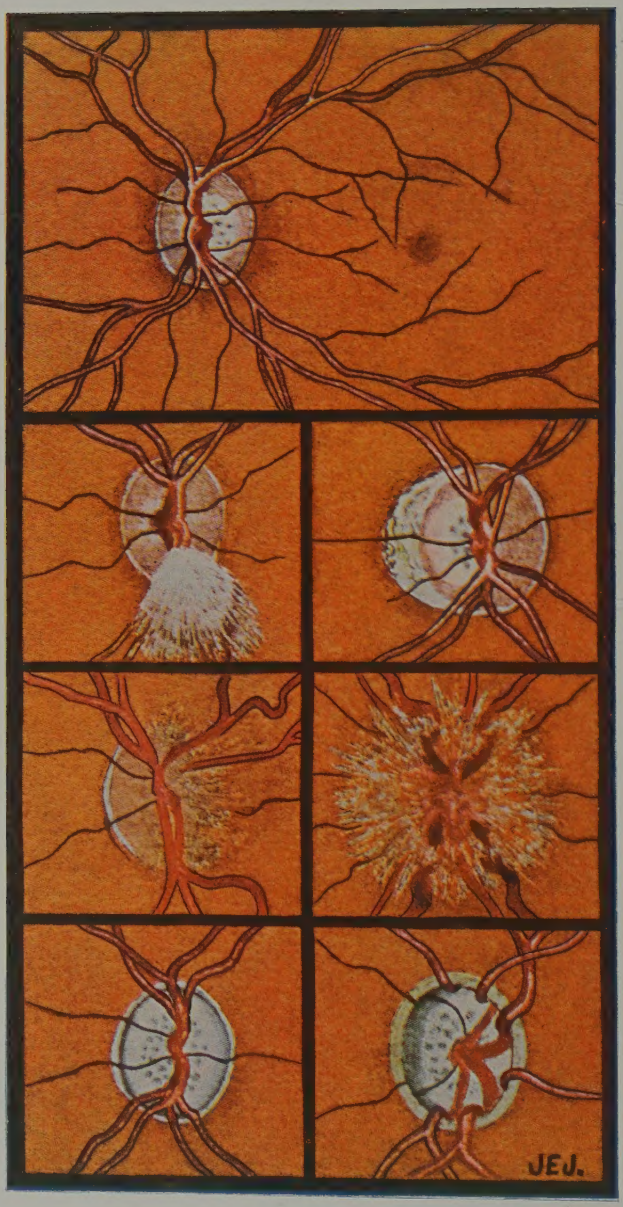
Albert A. Kolene M.D.
1920



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EXPLANATION OF THE FRONTISPIECE.

FIG. 1.—*Normal fundus* of the left eye as seen by the direct method. The ochre-red background shows a fine stippling due to the retinal pigment. The choroidal vessels are invisible. The optic disc is an upright oval, of a pinkish tint, with a white depression (physiologic cup). The gray spots at the bottom of the cup represent the openings in the *lamina cribrosa*. The faint white line encircling the pinkish zone is the *scleral ring*, and outside of this is a black line, the *choroidal* or *pigment ring*. The central artery (light red) and vein (darker red) emerge from near the center of the disc and ramify over the fundus in an arborescent manner, giving off fine twigs which encircle the small dark area to the right of the disc (macula region). In the black and white drawings which illustrate the text, the light streak on the veins is not shown.

FIG. 2.—*Opaque nerve-fibers* situated at the lower margin of the disc. They appear as a brilliant white patch which extends a short distance onto the retina and terminates in a feathery end. The retinal vessels are more or less concealed by the opaque fibers, but after emerging from the edge of the patch they pass on in a normal manner.

FIG. 3.—*Posterior staphyloma* or *myopic crescent*. At the temporal side of the disc is seen a white crescent of exposed sclerotic due to stretching and atrophy of the choroid in a myopic eye (3 D). The crescent is bounded by a faint line of black pigment.

FIG. 4.—*Optic neuritis, early stage*. The disc is stained a deep red and the outline of its nasal half is entirely obliterated.

FIG. 5.—*Optic neuritis, later stage* (choked disc). The inflamed disc is a deep red, mottled and streaked and almost twice its normal size. Its outlines are entirely obliterated. The arteries are narrowed, buried in the substance of the swelling, and first appear a little distance from its edge. The veins are greatly distended, very tortuous, and partially concealed until they reach the edge of the swelling.

FIG. 6.—*Primary optic atrophy*. The disc is grayish-white with a sharply cut scleral ring. The excavation is saucer-like, involving the whole disc, and the stippling of the lamina cribrosa is very distinct. The retinal vessels are slightly narrowed.

FIG. 7.—*Cupping of the optic disc in glaucoma*. The excavation is complete to the scleral margin and its edges are undermined. The vessels are crowded to the nasal side, bend sharply over the margin, and are lost to view until they reach the bottom of the cup, where they reappear, but out of focus. The lamina cribrosa is very distinct. A ring or halo of a yellowish-white color surrounds the disc, due to atrophy of the choroid.

A MANUAL

OF

OPHTHALMOSCOPY

FOR

STUDENTS AND GENERAL PRACTITIONERS

BY

J. E. JENNINGS, M.D.

(Univ. Penna.)

AUTHOR OF "COLOR-VISION AND COLOR-BLINDNESS," A PRACTICAL MANUAL FOR RAILROAD SURGEONS; FORMERLY CLINICAL ASSISTANT ROYAL LONDON OPHTHALMIC HOSPITAL, LONDON; FELLOW OF THE BRITISH LARYNGOLOGICAL AND RHINOLOGICAL ASSOCIATION; MEMBER OF THE AMERICAN MEDICAL ASSOCIATION; MEMBER OF THE ST. LOUIS MEDICAL SOCIETY, ETC.

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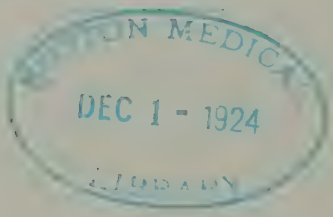

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SURGEONS TO THE ROYAL LONDON OPHTHALMIC HOSPITAL

BY THEIR FORMER ASSISTANT,

THE AUTHOR

PREFACE.

This manual is an elaboration of a series of lectures on ophthalmoscopy delivered before the graduating class of the Beaumont Hospital Medical College of St. Louis. The text is systematically arranged and profusely illustrated with many original black-and-white drawings and a colored frontispiece. The author feels that there is a demand for a manual of ophthalmoscopy adequately illustrated which will give in small compass and at slight cost information heretofore only to be obtained in expensive text-books and atlases. It is therefore offered to students, post-graduates, and general practitioners, with the hope that it may prove of use in enabling them to obtain a practical knowledge of the ophthalmoscope. Those who desire a more complete exposition of the subject should consult Loring's classic text-book, Gower's "Medical Ophthalmoscopy," and Frost's beautiful Atlas.

Carleton Building, Saint Louis, Missouri.
November, 1901.

CONTENTS.

CHAPTER I.

CHAPTER II.

CHAPTER III.

CHAPTER VI.

CHAPTER VII.

CHAPTER VIII.

LIST OF ILLUSTRATIONS.

OPHTHALMOSCOPY.

CHAPTER I.

THE OPHTHALMOSCOPE.

History.—Until the invention of the ophthalmoscope the interior of the eye was invisible. The ordinary black appearance of the pupil was supposed to be the result of an absorption of the light rays by the pigment cells of the retina and choroid. The first to throw a doubt upon this idea was Mery (1704), who, accidentally holding a cat under water, found that he could look through the pupil and see the details of the fundus with all ease. The red glare at times observed in the eyes of animals was thought to be a spontaneous development of light under the influence of the nervous system. This fallacy was disproved by Provost (1810), who found that the red glare could not be seen in a dark room, and must, therefore, be due to a reflection of incident rays. In 1846 Cummings announced the important fact that all eyes are luminous, but that in order to see the returning rays of light the eye of the observer must be placed as nearly as possible in the direct line between the source of light and the eye observed. That this is a difficult matter without the aid of some special

form of apparatus is shown by the following experiment: Suppose a lighted candle is held two feet in front of a patient's eye; the entering rays converge to form a distinct image of the candle flame on the retina. The reflected rays pass out of the eye in the same manner and come to a focus in the candle flame (conjugate focus), and at this point a picture of the fundus will be found. If we wish to observe this image it will be necessary to place our eye in the direct path of the returning rays, either in front of or behind the candle flame. If the observer gets in front of the flame, his head cuts off the light; if behind, the image is obscured by reason of the dazzling light and the opaque flame. In 1851 Helmholtz solved the problem by contriving an eye mirror, or ophthalmoscope, with which he was enabled to illuminate the eye and obtain a picture of the fundus. In his article describing the instrument, he says he "does not doubt that all the pathologic changes in the retina and vitreous humor so far observed in the cadaver can be seen in the living eye, a fact which promises great progress in the little known pathology of this organ."

Helmholtz's Ophthalmoscope.—(Fig. 1.) The original instrument consisted of three thin plates of glass, which formed the hypothenuse of a little box, or cell, having the form of a right-angled triangular prism, closed on all sides and blackened in the interior. The small side of this box, which formed with the plates an angle of 56 degrees, was pierced by a hole behind which was an eye-piece for the purpose of receiving the eye of the observer.

Theory.—If in a darkened room the light of a candle

or lamp be allowed to fall on the polished glass plates, and the rays reflected therefrom be made to enter the eye to be observed, an image of the fundus will be seen by an eye placed behind the glass. In this experiment

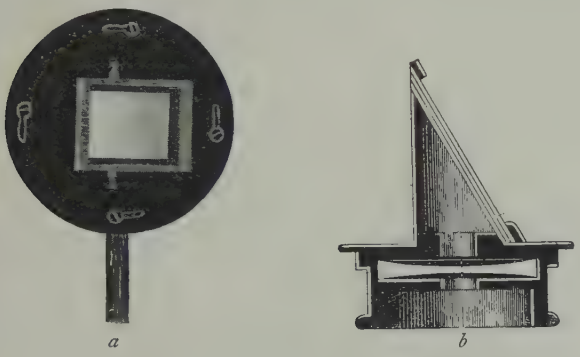

FIG. 1.—HELMHOLTZ'S OPHTHALMOSCOPE. *a*, Front view; *b*, sectional view.

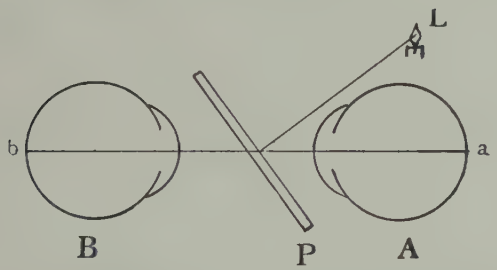

FIG. 2.—PRINCIPLE OF HELMHOLTZ'S OPHTHALMOSCOPE.

the eye of the observer is practically made the source of illumination, and consequently in a position to receive the rays of light returning to their conjugate focus (Fig. 2). The light from the candle L, falling obliquely on the glass plate P, is reflected and passes into the eye

A. The rays reflected from the fundus a, on reaching the glass plate P, are in part reflected to the original source of light L, while a part pass through the plate into the eye B and come to a focus at b.

Value of Helmholtz's Ophthalmoscope.—Although at the present time the original ophthalmoscope of Helmholtz is little more than a curiosity, and has given way to those of more improved construction, yet, by reason of its weak illuminating power, it is still unsurpassed in the detection of fine opacities in the vitreous and slight changes of the retina and optic nerve.

Improvements of the Ophthalmoscope.—Having discovered the ophthalmoscope and explained the optical principles involved, Helmholtz was content to allow other observers to improve the practical details of the instrument. Frobelius substituted for the three glass plates a right-angled prism with a hole drilled through it. Rekoss fastened to the metallic framework of Helmholtz's instrument two revolving discs (Fig. 3). Each of these discs had five openings, four of which were filled with concave lenses from 6 to 13 inches in focal length; the fifth was empty. Epkens' instrument consisted of an ordinary mirror with the silvering scraped from an oval space in the center. Reute was the first to use a concave mirror with a hole drilled through the center. The ophthalmoscope of Stellwag von Carion (Fig. 4) consisted of a concave perforated mirror fastened to a holder by a ball-and-socket joint, behind which was placed a Rekoss disc.

Liebreich's Ophthalmoscope.—This, until quite recently, was the one most commonly used, and consists

of a concave mirror about 1 ¼ inches in diameter and 8 inches focal length, with a central opening from 2 to 4 millimeters in diameter (Fig. 5). Behind the mirror, which is fixed upon a short handle, is a small clip for holding a convex or a concave lens. The original

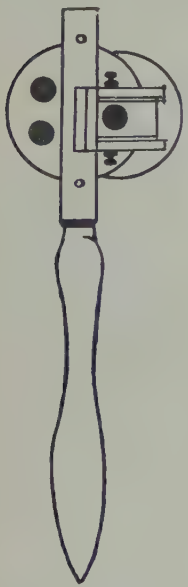

FIG. 3.—REKOSS'S OPHTHALMOSCOPE.

FIG. 4.—THE OPHTHALMOSCOPE OF STELLWAG VON CARION.

FIG. 5.—LIEBREICH'S OPHTHALMOSCOPE.

"Liebreich" had a metal mirror beveled to extreme thinness about the perforation, to prevent the interception of the peripheral light rays. The mirror of the later models is made of thin glass, with a central opening secured either by cutting a hole in the glass or re-

moving the silver from the central portion of the back of the mirror.

Loring's Ophthalmoscope.—The early model of the "Loring" (Fig. 6) consists of a concave stationary mirror with a central aperture embedded in a metal plate. Behind the mirror is a disc containing convex and concave lenses numbered in the metric and inch system. The latest model (Fig. 7) consists of an oblong concave

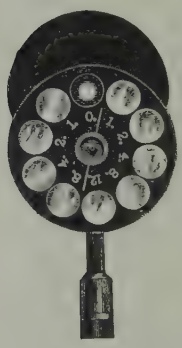

FIG. 6.—LORING'S OPHTHALMOSCOPE. EARLY MODEL.

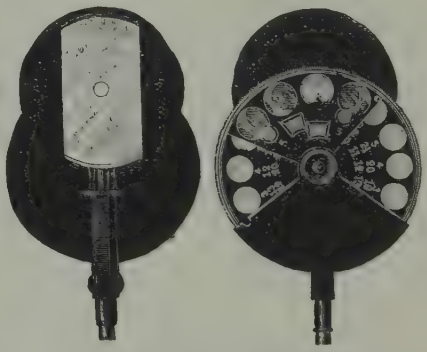

FIG. 7.—LORING'S OPHTHALMOSCOPE. LATER MODEL.

mirror swung upon two pins in such a manner that the mirror can be tilted 20 degrees to the right or left. The perforation is from 3 to 4 millimeters in diameter, and with practically no depth. This does away with the annoying reflections noticed when the perforation in the mirror has a thick edge. At the back of the frame which supports the mirror is a disc containing fifteen lenses from 1 to 7 plus and from 1 to 8 minus, and a quadrant containing four additional lenses, plus 0.5, plus

16, and minus 0.5 and 16. The first row of numbers beneath the glass shows the strength of the lens; and the second and third rows show the result of any combination up to plus 23 D and minus 24 D. The convex lenses are numbered in white and the concave in red.

Morton's Ophthalmoscope.—(Fig. 8.) This consists of twenty-nine separate lenses and an empty cell in an

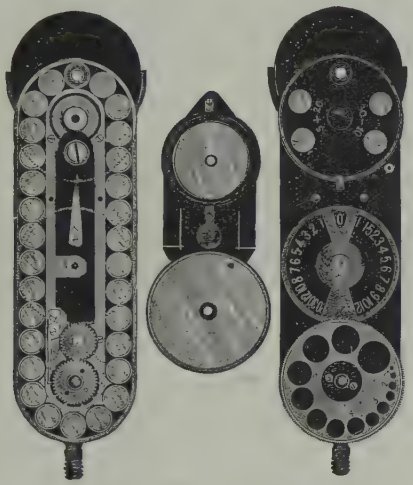

FIG. 8.—MORTON'S OPHTHALMOSCOPE.

endless groove and propelled by a driving-wheel situated at the lower end of the frame. At the same time that the driving-wheel propels the lenses, it rotates a disc on which at a certain aperture is indicated the lens presented at the sight-hole. The red numbers represent convex, and the white, concave lenses. In addition to the lenses just mentioned are four others, set in a separate disc, which are for use on special occasions. On

the front of the instrument is an arrangement similar to the nose-piece of a microscope revolving on a central pivot and carrying three mirrors. At one end are a plane and a concave mirror set back to back in one mounting, and are reversible. At the other end is a small slanting mirror of three inches focus. A pupillometer is set in the face of the driving-wheel.

The Selection of an Ophthalmoscope.—In selecting an ophthalmoscope the physician should remember that a good instrument is not necessarily expensive or complex, and that more depends upon the skill of the observer than the pattern of the ophthalmoscope. The accurate pictures of pathologic conditions of the fundus, found in Liebreich's Atlas, were all observed with the simplest instruments. The first point to consider in selecting an ophthalmoscope is the mirror. Some instruments are provided with both a plane and a concave mirror. The plane mirror gives a weak illumination, and is used when we wish to detect fine opacities of the media, or slight changes in the retina or choroid. The concave mirror gives a stronger illumination, and therefore is better adapted to routine work, and with a dim light may be made to serve the purposes of a plane mirror. It is therefore well to select an ophthalmoscope with a concave mirror made of very thin glass, and a focus of about 8 inches. The central perforation is often larger than necessary ; from 2 to 3 millimeters is about the proper diameter. The mirror may be stationary or tilting. With a stationary mirror the ophthalmoscope must be tilted toward the light, which is a serious objection when examining the fundus at close range. The

tilting mirror is swung upon two pins, and can be turned to any desired angle. A good working ophthalmoscope which can be carried in the pocket and which the student will find sufficient for all practical purposes is the Loring pattern with a tilting mirror and a single revolving disc.

The Dark-room.—Surgeons who limit their practice to diseases of the eye find it convenient to have a dark-room adjoining the office for ophthalmoscopic examinations. The room should be at least 8 feet square and the wall covered with black cloth or paint. While a special dark-room is desirable, it is not essential; and in fact many observers objecting to such close quarters convert the office into a dark-room as occasion requires by simply drawing the window shades. After a little practice it is quite easy to make an ophthalmoscopic examination by daylight, and as the physician is often called to make such examinations at the bedside, he should accustom himself to working in a moderately darkened chamber, or behind an improvised screen.

Illumination.—*1. Electricity.*—In the city, where electricity is extensively used for lighting purposes, it is convenient to have a wire run into the dark-room and attached to a swinging bracket. A frosted glass incandescent lamp is substituted for the ordinary one, which gives an annoying reflection of the intensely bright loop. Until recently, a serious objection to the use of electricity was that there was no way of regulating the intensity of the light, but an attachment can now be obtained which allows of a dim or of a bright light as occasion demands.

2. Gas.—For office work gas is a very convenient and ever-ready source of illumination. We can use an adjustable bracket with an Argand burner, or the gas can be conveyed through a flexible tube to an adjustable stand, which is placed on a desk or table. The Welsbach burner gives a bright and beautiful illumination, and is much favored by special workers.

3. Lamp.—If electricity or gas is not at our disposal, —for instance, in the country or at the bedside,—a lamp which burns with a clear, steady flame, or even a lighted candle, will be found to answer admirably. It is certainly of great advantage to cultivate the faculty of making ophthalmoscopic examinations standing or sitting, in the office or in the bedroom, by electric, gas, or candle light.

The Use of Mydriatics.—It is of course very desirable to be able to examine the fundus without employing a mydriatic. In most cases the pupil dilates to a considerable degree in the dark-room, and any change in the eye can be observed. As the optic disc is not sensitive, the light can be directed in that direction without inconvenience; but, on the other hand, if the light is turned toward the sensitive macula region, the pupil contracts, and, owing to the corneal reflections of the mirror and to the insufficiency of the illumination, the view is often unsatisfactory. As even experts at times overlook pathologic changes which would have been apparent at a glance had a mydriatic been used, the student should always employ it when the diagnosis is uncertain, or when a careful examination of the fundus is to be made. The objections to the use of a mydriatic are:

1. The possibility of setting up an acute glaucoma. This danger can be reduced to the minimum if the precaution is always taken to ascertain the tension of the eyeball and examine for other evidences of glaucoma.

2. If sudden loss of vision occurs in neuritis or atrophy of the nerve, this loss of sight may be attributed by the patient to the effect of the mydriatic. But if the diagnosis is made and the patient is told of his condition, there would be no grounds for such a complaint.

3. Inconvenience to the patient. This is very slight since the introduction of the weaker mydriatics, cocain, homatropin, and euphthalmin, each of which may be used in the strength of 10 grains to the ounce of distilled water.

CHAPTER II.

THE OPHTHALMOSCOPIC EXAMINATION.

The ophthalmoscopic examination comprises four methods: (1) The oblique or focal illumination; (2) the direct method at a short distance from the patient; (3) the indirect method; (4) the direct method close to the patient.

In order to make a thorough study of the eye a systematic examination is of the greatest importance. Each method tells its own story, and it is only by a careful review of the facts thus obtained that a comprehensive and reliable diagnosis can be made. Those who begin the examination by employing the direct or indirect method very frequently overlook the fact that the media are not perfectly transparent, and jump to the conclusion that the retina is hazy or that there is an inflammation of the optic disc. Slight opacities of the cornea, lens, or vitreous are best seen by oblique illumination or by the direct method at a short distance from the patient, and should be sought for before going further.

1. The Oblique or Focal Illumination.—*The Object Lens.*—For the oblique illumination a large convex "object lens" of 13 D is required (Fig. 9). The one which is sold with the ophthalmoscope is usually too small. It should be about 2¼ inches in diameter, and have a metal rim and handle, or the rim may be

omitted and the handle attached directly to the lens by means of two rivets. The great advantage of a handle is that during the examination by the indirect method the surgeon's hand rests on the forehead or cheek of the patient and is out of the way. This lens should be kept clean, as any specks of dirt on it will appear as black dots on the patient's retina.

The Examination by Oblique Illumination.—To examine the eye by oblique illumination the patient is seated

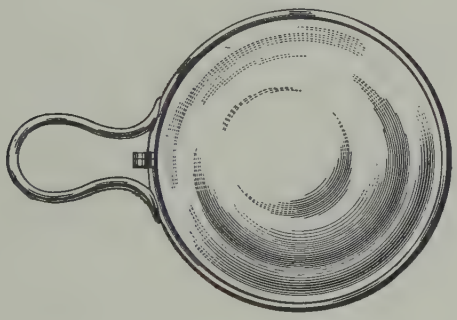

FIG. 9.—OBJECT LENS.

in a chair in the dark-room and looks directly forward (Fig. 10). The lamp is placed about 18 inches in front and a little to one side of the eye to be examined. The surgeon stands or sits on a stool in front of the patient, raises the upper lid with the thumb of one hand, while with the other he holds the large lens between the eye and the lamp and brings the rays to a focus on the cornea. The bright point of light is then made to move slowly over the whole area of the cornea, and any unevenness of its surface, a small foreign body or a very fine

opacity, is easily discovered. Having examined the cornea, the object lens is brought slightly nearer and the cone of light thrown on the iris and the pupillary area. We look for any attachments of the iris to the lens capsule (posterior synechiæ) or small dots of pig-

FIG. 10.—OBLIQUE OR FOCAL ILLUMINATION.—(*Lang.*)

ment on the capsule, which denote a previous iritis and points of iritic adhesion.

The object lens is now brought a little nearer to the eye, and the nucleus, the posterior capsule of the lens, and the anterior portion of the vitreous are inspected. It should be remembered that in examining the lens and anterior portion of the vitreous by this method

the eye of the surgeon must be kept close beside the object lens to catch the rays that are reflected by these deeper structures.

The Compound Lens.—If during the course of this examination any abnormal condition is discovered, a magnified view of it may be obtained by means of a compound lens which magnifies about four diameters and has a flat focus at three-fourths of an inch (Fig. 11). The part is illuminated with the object lens, and the compound lens is held about three-fourths of an inch from the eye, at the same time elevating the upper lid with the fingers of the same hand. (See Fig. 10.)

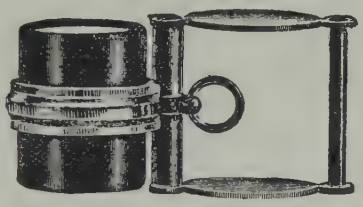

FIG. 11.—COMPOUND LENS.

2. The Direct Method at a Short Distance from the Patient.—The lamp is now placed close to the patient's head on a level with the ear, so that the eye remains in shadow. (See Fig. 12.) Standing or sitting about 2 feet in front, the surgeon, keeping both eyes open, looks through the sight-hole of the mirror and reflects the light into the eye. The pupillary area, which ordinarily appears black, is now brilliantly illuminated and of a bright red color. By this method the details of the fundus are not visible, but only a brilliant area of red, which is called the fundus reflex. At some point in this red area is seen the "corneal reflex," a small bright image of the source of light. If we are examining the right eye, and the patient looks over our left shoulder,

the bright red of the fundus is seen to change to a canary yellow. This is due to the fact that we are viewing the reflex from the optic disc, which is much lighter in color than the rest of the fundus. The patient is now requested to move his eye in various directions. Any opacity of the cornea, lens, or vitreous will appear as a black mass in the red field. If it is located in the cornea or anterior portion of the lens, the black mass moves up when the

FIG. 12.—THE DIRECT METHOD AT A SHORT DISTANCE.—(*Lang.*)

eye is turned in that direction, or down when the eye is turned down. An opacity seated in the posterior portion of the lens, or a fixed opacity in the vitreous, moves in an opposite direction—*i. e.*, moves down when the eye is turned up, etc. (See page 50.) If the whole lens is opaque (ripe cataract), or the vitreous is filled with blood, the fundus cannot be illuminated, and of course there will be an absence of the red reflex. If we wish to determine the presence of floating vitreous opacities, the patient is

requested to move his eye about rapidly, and then to look straight ahead. In this way the opacities are stirred up, and we see them as dark masses floating about in the illuminated area. The fine dust-like opacities of the vitreous, so characteristic of syphilis, are best seen in a dim light by the direct method close to the eye, and with a convex lens of 10 D.

As stated above, when the fundus is viewed by the direct method at a short distance from the patient, we do not see the details of the fundus. But sometimes we do catch glimpses of the disc, blood-vessels, etc.; and when we do, it always indicates myopia or hypermetropia. If these details of the fundus are seen easily and distinctly, then in all probability it is an inverted image, and the eye is myopic. If only a passing glimpse of a large vessel is obtained, then very probably we have to do with a direct image, and the eye is hypermetropic.

3. The Indirect Method.—Thus far our ophthalmic examination has been confined to the anterior segment of the eyeball. Having noted the condition of the cornea, anterior chamber, iris, pupil, lens, and vitreous body, our next step is to study the fundus or background of the eye, first by the *indirect*, and then by the *direct* method. We employ the indirect method first, because while the view is less magnified, it is more extensive, and we are enabled at a glance to get a general idea of the fundus and the extent of any diseased conditions present.

The Examination by the Indirect Method.—To examine the fundus by the indirect method, the light, at its brightest, is placed on a level with and a little behind the ear of the patient. The surgeon, sitting or standing about

2 feet away, looks through the sight-hole of the ophthalmoscope, and reflects the light from the mirror into the eye. When the red reflex is obtained, the object lens, which is held between the thumb and forefinger of the

FIG. 13.—THE INDIRECT METHOD.—(*Lang.*)

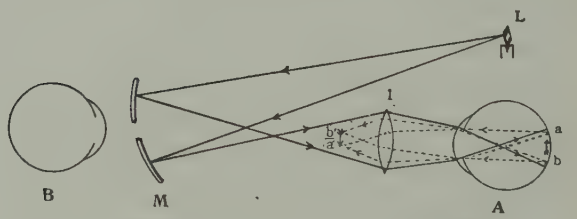

FIG. 14.—FORMATION OF IMAGE—INDIRECT METHOD.

Rays of light reflected from M pass through the lens 1 and focus in the eye A at a, b. The returning rays are focused by the lens 1 at b′, a′, so that at that point will be visible an aerial and inverted image of a, b.

left hand, is brought into position about 2½ inches in front of the patient's eye, as shown in Fig. 13. As the optic disc is the most conspicuous part of the fundus, it is customary to make it the starting-point of our investigation. To bring the optic disc of the right eye into

view, the patient is instructed to look, without turning his head, over the surgeon's right shoulder; if the left eye is being examined, the patient is told to look at the left ear of the surgeon. Under these circumstances an inverted image of the disc, which may or may not be clearly defined, comes into view. In order to focus this image, the object lens is moved slightly backward until the optic disc is seen distinctly.

The observer may be annoyed by the two reflections of the lamp formed on the anterior and posterior surfaces of the object lens. These may be gotten out of the way by moving the lens up or down, or by slightly tilting it. After a little experience the observer will find it convenient to place behind the sight-hole of his ophthalmoscope a convex spherical lens of 3 or 4 D. By this means he relaxes his accommodation and enlarges still more the aerial image. Having examined the disc, the surgeon studies the remainder of the fundus, and to this end directs the patient to look in various directions —upward, downward, inward, and outward.

The dark, misty ring, which denotes the *macula* or *yellow spot*, appears to view when the patient looks directly at the sight-hole of the mirror. Often it is extremely difficult to make out the macula, on account of the contraction of the pupil, which occurs when the light strikes this, the most sensitive portion of the retina. This contraction may be obviated to some degree by directing the patient to look, not at the mirror, but just above it at the observer's forehead. At its best, however, the indirect method is inferior to the direct when we desire to examine the macula region.

Some idea as to the *refraction* of the eye may be obtained by means of the indirect method. If, while examining the disc, it appears to increase in size as the object lens is gradually withdrawn from the eye, it denotes myopia; if the disc appears to diminish in size, the eye is hypermetropic; while if no change is noticed, the eye is emmetropic or the refractive error is slight.

The indirect method is also of value in estimating the elevation of a swollen disc, or the depth of a physiologic or of a glaucomatous cup. If the object lens is moved from side to side while viewing, for instance, a glaucomatous cup, a *parallactic* movement is observed; that is, the vessels on the edge of the disc move in front and faster than do those at the bottom of the nerve. (See page 59.)

In high degrees of myopia (12 D or more) we are forced to rely almost entirely upon the indirect method for information as to the condition of the fundus. The strong minus glass which has to be used to correct the myopia by the direct method so darkens the fundus that it is difficult to get a satisfactory view. In cases where the pupil is very small, or is bound down by adhesions, or where there are opacities in the lens or vitreous, the indirect method is of great value, and often is the only method by means of which we can catch a glimpse of the fundus. Finally, there are occasions when we desire to keep at a respectful distance from our patient, who may, perhaps, be suffering from ozena, pediculosis, etc., and in these cases the indirect method is to be commended.

4. The Direct Method Close to the Patient.—Hav-

ing acquired a knowledge of the general characteristics of the fundus by the indirect method, we next proceed to study it in detail. For this purpose we use the *direct method*, the most beautiful, important, and satisfactory means yet devised for the exploration of the fundus. As the image is erect and magnified about fifteen diameters, we are often able to detect slight but significant changes

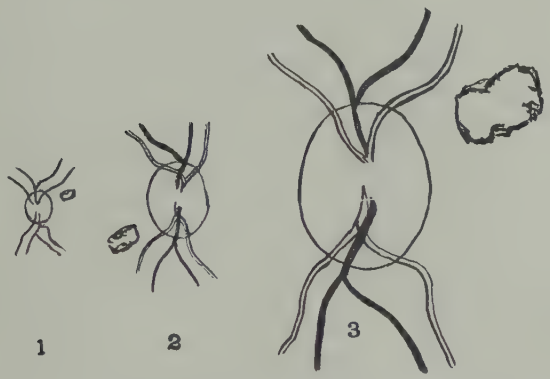

FIG. 15.

1, The real size of the optic disc; 2, the enlargement by the indirect method (inverted image); 3, the enlargement by the direct method.

which would escape notice by any other method (Fig. 15).

The Examination by the Direct Method.—Having seated the patient on a chair, the surgeon directs him to look straight ahead at some object on the other side of the room. By this means we relax to a great extent his accommodation, dilate the pupil, and bring the optic disc into line. If the right eye is to be examined, the light is placed close to the patient's right ear. The surgeon

sits on the right side, and draws his chair as close as possible to the patient, so that he can look into the eye without discomfort. Holding the ophthalmoscope in the right hand, and with the index finger controlling the refracting lenses, the surgeon, using the right eye, looks through the sight-hole, and at a distance of 5 or 6 inches reflects the light into the patient's eye. Having obtained

FIG. 16.—THE DIRECT METHOD.—(*Lang.*)

the red reflex, and taking care to keep the mirror so turned that it will steadily reflect light into the patient's pupil, he gradually approaches until the ophthalmoscope is within 1 or 2 inches of the eye under examination. (See Fig. 16.) He will now, if accommodation is relaxed and the eye is emmetropic, see a distinct image of the fundus. If the left eye is to be examined, substitute the word "left" for "right" in the above description. The

optic nerve is the first object which we desire to see, and to find it with the least possible delay, the patient should look straight ahead, and the surgeon approach slightly from the temporal side and look obliquely backward and inward. Or, if the patient is unsteady, the surgeon may select a large blood-vessel and follow it down to the optic disc.

If the disc and vessels appear blurred with relaxed accommodation, the eye is hypermetropic or myopic, and must be corrected by a proper glass. The surgeon does this by revolving the lenses in front of the sight-hole until a clear image is obtained.

We next examine the yellow spot, which lies about two disc-breadths to the temporal side of the disc. The surgeon either changes the position of his head and searches for it, or directs the patient to look directly at the sight-hole of the mirror. Having noted the appearance of the disc and macula region, we next make a systematic examination of the peripheral portions of the fundus by following the main branches of the retinal vessels from the disc to the periphery. The patient assists in this examination by looking in various directions—upward, downward, inward, or outward, at the direction of the surgeon.

To Estimate the Refraction by the Direct Method.—To estimate the refraction by the direct method the patient is instructed to look straight ahead into darkness. The surgeon, selecting a small retinal vessel running upward from the disc or near the yellow spot, slowly revolves the ratchet or wheel and notes the strongest convex or the weakest concave lens with which the vessel is seen

distinctly. Then selecting a vessel which runs outward or inward from the disc or near the yellow spot, he notes the lens which clears up the horizontal vessel. The difference between the two lenses represents the amount of astigmatism present. If, however, both vessels (vertical and horizontal) are seen distinctly through the same lens, then the eye is simply hypermetropic or myopic, and only requires a spherical lens to correct the defect. Say, for instance, two vessels running at right angles to each

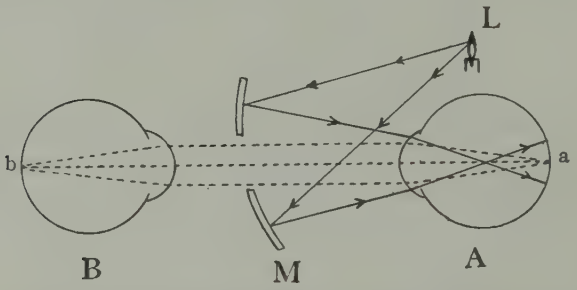

FIG. 17.—FORMATION OF IMAGE, DIRECT METHOD.

Rays of light reflected from the mirror M come to a focus at a in the eye A; the returning rays passing through the hole in the mirror M focus at b in the eye B.

other are seen distinctly with a +2 D lens; the eye is hypermetropic and needs a convex lens of 2 D to correct the error. If, however, the vertical vessel is best seen with a +3 D lens, while a +1 D is the strongest lens with which the horizontal vessel is seen clearly, then we have hypermetropia of 1 D associated with astigmatism of +2 D, and the compound lens required to correct the defect will be a spherical +1 D combined with a cylinder +2 D axis vertical.

In order to accurately estimate the refractive error by the direct method, the accommodation of both patient and surgeon must be entirely relaxed. We accomplish this to a great degree for the patient by directing him to look straight ahead into darkness. If this fails, the

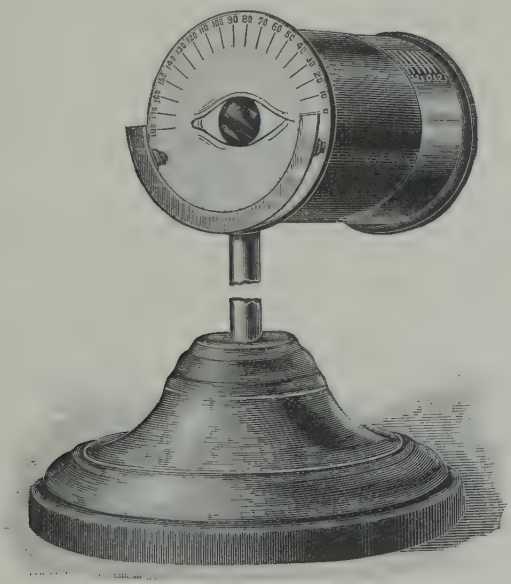

FIG. 18.—THORINGTON'S SCHEMATIC EYE.

muscle of accommodation must be paralyzed by the use of a cycloplegic. In regard to the surgeon, he should wear glasses which fully correct any error of refraction, and then by continuous practice learn to relax his accommodation at will. Dr. J. Thorington, of Philadelphia, has invented a schematic eye (see Fig. 18) which

is a valuable aid to those who wish to practice ophthalmoscopic refraction at their leisure and at small expense. It consists of two brass cylinders, one slightly smaller than its fellow, to permit slipping evenly into the other. Both cylinders are well blackened inside. The smaller cylinder is closed at one end with a concave surface, upon which is placed a colored lithograph of the normal fundus. The larger cylinder is closed at one end, except for a central round opening 10 millimeters in diameter, which is occupied by a +16 diopter lens, and on its outer surface is a colored lithograph of the normal eye with its appendages. On the side of the small cylinder is an index, which records emmetropia and the amount of hypermetropia or myopia, according as it is pushed into or drawn out of the large cylinder. The student should remember that it is only by constant practice, and by comparing his results with those obtained by other methods, that he can hope to become proficient in that most difficult of all accomplishments—to refract correctly by the direct method. Even then it is never advisable to order correcting lenses without corroborating the ophthalmoscopic findings.

Sometimes, in examining the fundus, we find a tumor, a swollen nerve, or an excavated disc, and it is very desirable to gain an idea of its extent. This we do with the direct method by first estimating the refraction of the higher level, then the lower. The difference represents the swelling or the excavation, and may be expressed in diopters or millimeters, remembering that 3 D = 1 mm.

Retinoscopy-skiascopy, or the *shadow test,* is now recognized as the most valuable objective method of estimating errors of refraction. The principle of the test is that when light reflected from a mirror (plane or concave) is thrown into an eye at a distance of 1 meter or more, we observe a bright red fundus reflex and a surrounding shadow. If the mirror is now moved in various directions, this shadow is seen to move across

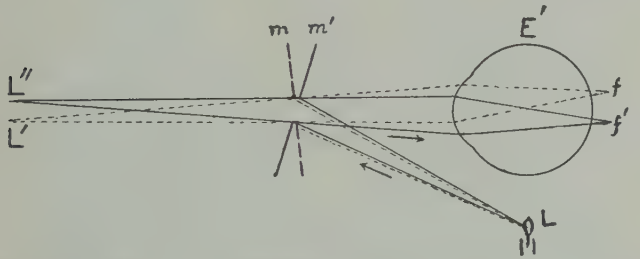

FIG. 19.—DIRECTION OF MOVEMENT OF REFLEX WITH THE PLANE MIRROR IN EMMETROPIA AND HYPERMETROPIA.

The erect reflex of the virtual image of the candle-flame, L, is shown at f'. The mirror m has been tilted downward to m', causing the virtual image L' of the light L to be lifted to L''. The divergent rays proceeding from L'' into the observed eye E' now fall at a lower point behind the retinal plane, showing that every downward inclination of the mirror is accompanied by a downward movement of the illuminated retinal area.—(*Norris and Oliver.*)

the pupil in the same or opposite direction, according to the refractive condition of the eye. As a plane mirror is commonly used, a description of the method by its aid will be given.

In *hypermetropia* the divergent rays of light from the candle L (Fig. 19) strike the plane mirror m, and are reflected into the eye E', in a divergent manner, just as though they had proceeded from L' (the virtual image

of L) behind the mirror. After passing into the eye they come to a focus behind the retinal plane at F. In emmetropia and in hypermetropia the rays coming out of the observed eye are parallel and divergent respectively, forming an upright image, so that the apparent movement of the reflex is in the *same direction* as the movement of the mirror. The mirror m has been tilted downward to m′, causing the virtual image L′ of the

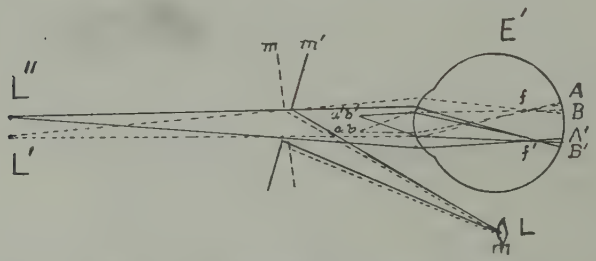

FIG. 20.—DIRECTION OF MOVEMENT OF REFLEX WITH THE PLANE MIRROR IN MYOPIA.

The mirror m being tilted downward to m′, we find that the aerial image of A′ B′ is at a′ b′, or higher than the aerial image a b of the original focusing area A B; that is, the inferior portion of the eye-ground naturally gives its aerial image in the superior part of the visual field. Therefore, when the mirror is tilted downward, the aerial image of the reflex is lifted.—(*Norris and Oliver.*)

light L to be lifted to L″. The divergent rays proceeding from L into the observed eye E′ now fall at a lower point f′, behind the retinal plane.

In Myopia.—If the observed eye is myopic, the apparent motion of the reflex is *contrary* to the movement given to the mirror. This is because we are observing an aerial image between the mirror and the patient (at his far point), and as the inferior portion of the eye-

ground naturally gives its aerial image in the superior part of the visual field, by following out the projections from the lower focus area A′ B′ (Fig. 20), we find that its aerial image a′ b′ is higher than the aerial image a b of the original intraocular focusing area A B. Hence, when the mirror is tilted downward, the aerial image of

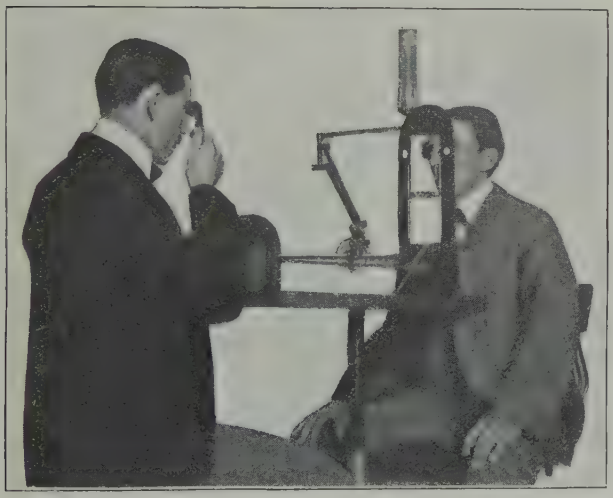

FIG. 21.—THE AUTHOR'S SKIASCOPE.

the reflex is lifted—*i. e.*, it moves in a contrary direction. There is one exception to this rule. In low degrees of myopia (less than 1 D), if the observer be nearer the patient than his far point, the image will move with the mirror.

Method of Examination.—To obtain accurate results a cycloplegic (homatropin, gr. x, to water, ℥j) should be

used. The dilatation of the pupil renders the examination easier and allows us to estimate the refraction of the macula.

The patient is seated behind the author's skiascope in the dark-room, and his head is so adjusted that the eye to be examined is directly behind the aperture (Fig. 21). The other eye is covered with a metal disc. Instead of the skiascope, a trial frame may be used. The lamp is placed over his head, so far back that the eye remains in shadow. The observer sits about 1 meter in front of the patient, and while controlling the movements of the lenses with his left hand, reflects the light from the mirror into the eye (Fig. 22). The patient is instructed to look at the mirror, or, if a cycloplegic is not used, at the forehead just above the mirror. The observer, having obtained the red fundus reflex, tilts the mirror slightly from side to side on its vertical axis, and then up and down on a horizontal axis. During the movements a shadow will be observed to pass more or less rapidly across the pupil, either in the same or in the reverse direction to the mirror. A bright reflex and a rapidly moving shadow denote a low degree of refrac-

FIG. 22.—THE AUTHOR'S RETINOSCOPY MIRROR.

tive error, while a dim reflex and a slowly moving shadow denote a high degree of error.

Hypermetropia.—When the shadow moves across the pupil in the same direction as the movement of the mirror, the eye is emmetropic, hypermetropic, or slightly myopic—less than 1 D. A convex spheric lens of 0.25 D is now turned in front of the eye and this changed for a stronger number, until that one is reached which reverses the shadow—*i. e.*, makes it move in the opposite direction to the movement of the mirror. The measure of the hypermetropia is 0.75 D *less* than the glass so found. For example, if the weakest convex lens (0.25 D) reverses the shadow, the eye is myopic 0.50 D (+0.25 D — +0.75 D = —0.50 D); if a +0.75 D reverses the shadow, the eye is emmetropic (+0.75 D — +0.75 D = 0); if a +2.75 D reverses the shadow, the eye is hypermetropic +2.00 D (+2.75 D — +0.75 D = +2.00 D).

Myopia.—If, in the first instance, the shadow moves across the pupil in the opposite direction to the movement of the mirror, the eye is myopic, and concave spherical lenses are rotated in front of the eye until the weakest one is reached which makes the shadow move with the mirror. The measure of the myopia is 0.75 D *more* than the glass so found. For example, if the shadow is reversed (made to move in the same direction as the mirror) by a —1.00 D lens, the eye is myopic 1.75 D (—1.00 D + —0.75 D = 1.75 D).

Astigmatism.—If there is a difference in the movement of the shadow in two opposite meridians, astigmatism is present. If this difference is only one of degree,

it is a case of simple or compound astigmatism; but if the shadow in one meridian moves with the mirror, and against in the opposite, the case is one of mixed astigmatism. In estimating the degree of astigmatism we correct each of the principal meridians separately with spherical lenses. In compound astigmatism the difference between the two lenses indicates the degree of astigmatism and also the cylinder which must be combined with the spherical lens which corrects the least ametropic meridian. In mixed astigmatism the number of the cylinder is obtained by adding the two lenses, while one or other of them, usually the +D, is used as the spherical lens. When the shadow moves obliquely across the pupil, the mirror is rotated around an oblique axis, and we can thus often estimate very accurately the axis of a cylinder.

Example of Simple Hypermetropic Astigmatism.— Suppose, when the mirror is moved up and down, the shadow moves with the mirror, but is reversed by a +0.75 D; then the eye is emmetropic in the vertical meridian; if the mirror is now moved from side to side, and the shadow is reversed by a +2.75 D, the eye is hypermetropic 2.00 D in the horizontal meridian and a +2.00 D cylinder axis vertical (90°) will be required to correct the defect.

Example of Compound Hypermetropic Astigmatism.— If, when the mirror is moved up and down, a +2.00 D reverses the shadow, while a +3.00 D is required to reverse the shadow when the mirror is moved from side to side, the following combination will correct the defect: +1.25 D sph. ⌓ +1.00 D cyl. ax. 90°.

Example of Mixed Astigmatism.—If, when the mirror is moved from side to side, the shadow moves with the mirror, but is reversed by a +2.00 D, and if, when the mirror is moved up and down, the shadow moves against the mirror, but is reversed by a —1.00 D, the following combination will correct the defect: +1.25 D sph. ⌓ —3.00 D cyl. axis horizontal (180°). In this instance you will notice that we add the two lenses to get the cylindrical and deduct the customary 0.75 D from the +2.00 D to get the spherical.

When the examination of both eyes is completed, the correcting lenses are placed in the trial frame, the visual acuity tested, and any slight change in the axis or strength of the lens is made. A drop of a 1 per cent. solution of eserin may be instilled to neutralize the effect of the cycloplegic, and after the eyes have returned to the normal condition, they are again tested subjectively and the proper glasses ordered. In hypermetropia the spherical lens ordered will have to be from 0.75 D to 1.00 D weaker than the correction under the cycloplegic; in myopia, from 0.25 D to 0.75 D stronger. No change should ever be made in the cylinder.

CHAPTER III.

EXAMINATION OF THE MEDIA OF THE EYE.

The Cornea.— (*a*) *Oblique or Focal Illumination.*— Under ordinary circumstances the cornea appears perfectly transparent, but if it is examined by oblique illumination a faint, smoke-like haze is observed which is most marked in the eyes of adults. Slight abrasions of the cornea, minute dots due to inflammation of the cornea, iris, or ciliary body, foreign bodies, ulcers, nebulæ, etc., are easily detected and appear in their *true color and form.* A magnified view of any defect discovered may be obtained by means of the compound lens.

The Cornea.—(*b*) *With the Ophthalmoscope.*—When light is thrown into the eye from a short distance, a red reflex is obtained and any opacities in the cornea will appear as black spots. A very delicate opacity may be overlooked unless weak illumination is used. Care should be taken that the black spots due to reflection of the eyelashes or to shreds of mucus which adhere to the cornea are not mistaken for permanent opacities. A magnified view of any opacity in the cornea is obtained by approaching close to the patient and using a +20 D lens behind the ophthalmoscope.

The Aqueous Humor and Iris.—(*a*) *Oblique Illumination.*—The transparency of the aqueous chamber is often dulled by inflammatory exudation from the iris and

ciliary body. Care is required to distinguish between turbidity of the aqueous and diffuse opacity situated in the deeper layers of the cornea. Blood or pus in the aqueous usually sinks to the bottom of the anterior chamber and is easily detected by the naked eye or by oblique illumination. Adhesions between the cornea and iris (anterior synechiæ), adhesions between the iris and lens (posterior synechiæ) (Fig. 23), thread-like remains of the pupillary membrane, exudations upon the surface of the lens, and the remains of capsule after an operation for cataract can be more satisfactorily studied with

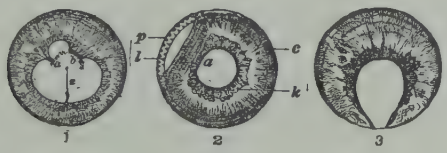

FIG. 23.

1, Posterior synechiæ; 2, iridodialysis (separation of the iris from the ciliary body); 3, congenital coloboma of the iris.—(*Fuchs.*)

oblique illumination than with the ophthalmoscope. Oblique illumination in conjunction with the magnifying lens enables us to study increased vascularity of the iris, tumors, cysts, and other irregularities of its surface.

The Aqueous Humor and Iris.—(*b*) *With the Ophthalmoscope.*—Perforation of the iris and detachment from its ciliary border (Fig. 23) may be readily detected by the red reflex which is seen through the opening. Important information is also obtained as to the clearness, size, and shape of the pupillary space.

The Lens.—(*a*) *Oblique Illumination.*—When the nor-

mal lens is examined with oblique illumination, its want of transparency is shown by an exceedingly delicate network of radiating striæ. Much more conspicuous is the smoke-like opacity seen in the eyes of old people, which results from the increased amount of light reflected from the hardened lens. Under daylight or with oblique illumination this opacity resembles cataract, but with the

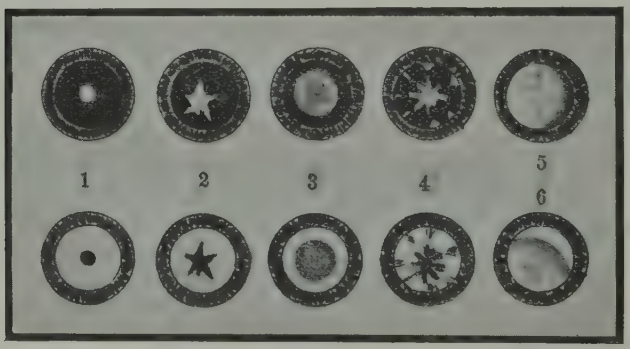

FIG. 24.—VARIOUS FORMS OF OPACITY OF THE LENS. THE UPPER ROW AS THEY APPEAR BY OBLIQUE ILLUMINATION. THE LOWER ROW AS SEEN BY TRANSMITTED LIGHT (DIRECT METHOD).

By oblique illumination the opacity is seen in its true color. 1, Anterior polar cataract; 2, posterior polar; 3, lamellar cataract; 4, early stage of senile cataract; 5, senile cataract not quite ripe, for if a light is thrown on the eye from the right side the iris casts a shadow on the lens.

ophthalmoscope the lens is found to be perfectly transparent. Care should therefore be taken not to make a hasty diagnosis of cataract from the appearance the lens presents with the oblique illumination. All opacities of the lens appear under oblique illumination in their *true color*. In order to make a thorough examination of the lens the pupil must be dilated.

Anterior polar cataract or pyramidal cataract appears as a small, sharply defined whitish mass which projects slightly from the center of the anterior capsule and is usually due to contact of the lens and cornea, the result of a perforating ulcer in ophthalmia neonatorum (Fig. 24). A small nebula may often be seen in the cornea at the site of the perforation.

Posterior polar cataract appears as a small, round or star-shaped opacity seated in the deepest layers of the lens near the posterior pole. The spike-like projections take the curve and plane of the posterior capsule. This form of cataract is usually congenital and often associated with persistent hyaloid artery and other malformations.

Lamellar cataract is congenital or forms in early infancy and consists of an opaque layer or zone included between a transparent nucleus and cortex. In most cases this form of cataract remains stationary, but if slight opacities are observed in the otherwise clear cortex, the whole lens is apt to become opaque in course of time.

Senile Cataract.—In the incipient stage the opacity takes the form of diffuse opacity, of gray flocculi, dots, and lines scattered through the cortex, or of triangular sectors with the bases toward the equator of the lens and the apices toward its center. Gradually the cataract progresses until the whole lens is opaque, and if examined at this time with focal illumination, the thickness of the capsule alone will intervene between the pupillary margin of the iris and the opacity. If a distinct shadow of the iris is thrown upon the lens, it is evident that the

most peripheral layers of the cortex are still transparent.

Secondary cataracts occur as the result of injury or operation. They appear as delicate, almost transparent membranes or dense opacities which occupy the pupillary space.

Foreign bodies, such as particles of steel or stone, em-

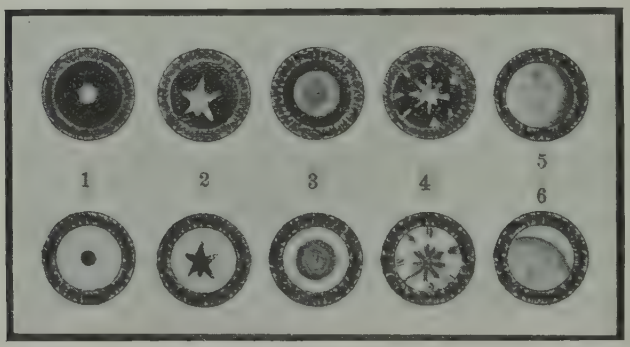

FIG. 25.—VARIOUS FORMS OF OPACITY OF THE LENS. THE LOWER ROW AS THEY APPEAR BY TRANSMITTED LIGHT.

An opacity of the lens seen by the direct method appears black on a reddish background. 1, Anterior polar; 2, posterior polar; 3, lamellar; 4, early stage of senile cataract; in mature senile cataract the pupil appears black and without the red reflex; 6, dislocation of the lens.

bedded in the lens can often be detected with oblique illumination when they are invisible with the ophthalmoscope. In many cases we are able to follow the track of a foreign body through the cornea and lens, and thus be convinced of its presence in the eye, although no longer in sight.

The Lens.—(*b*) *With the ophthalmoscope* all opacities

in the lens appear as black striæ, spots, or patches against the reddish-yellow background of the fundus (Fig. 25). Isolated opacities in an otherwise clear lens may exist for years without change in size and shape, so that in many cases it is unnecessary to alarm the patient by mentioning the fact that such an opacity exists. In *lamellar cataract* the center of the lens is less dense than at the margin of the opaque portion, while a narrow zone of perfectly transparent lens is found at the periphery of the lens.

Dislocation of the lens is easily detected with the ophthalmoscope if the pupil is dilated. Somewhere in the pupillary space the border of the lens appears as a narrow dark rim (Fig. 25, No. 6), and if we approach close to the patient and use a +16 lens behind the ophthalmoscope, we may sometimes distinguish the ciliary processes, which appear as fine grayish lines.

The Vitreous.—(*a*) *Oblique Illumination.*—Large vitreous opacities and hemorrhages when situated in the anterior part of the vitreous may be detected with oblique illumination. The bright yellow reflex of glioma of the retina or purulent choroiditis, as well as extensive detachment of the retina, may also be observed. But as a rule opacities in the vitreous are better studied with the ophthalmoscope than with oblique illumination.

The Vitreous.—(*b*) *With the Ophthalmoscope.*—Inflammation of the surrounding structures, such as retinitis and choroiditis, almost always leads to the formation of vitreous opacities. They vary much in size, shape, and position, and usually appear as black spots suspended or floating about in an otherwise transparent

medium. If the opacity is semi-transparent, or is turned so that the light is reflected from its surface, it will appear gray; bits of metal suspended in the vitreous may retain their metallic glitter, but if encapsulated they usually appear dark. In rare cases crystals of cholesterin are found in the vitreous as a senile change and appear as innumerable minute floating particles which sparkle like gold leaf (sparkling synchysis).

Diffuse Opacities of the Vitreous.—These are usually due to a low type of retinitis and choroiditis, especially the syphilitic variety. With the ophthalmoscope at a short distance from the patient the effect of the diffuse opacity in the vitreous is to blur the details of the fundus, and often leads to the mistaken diagnosis of papillitis. Before coming to any definite conclusion it is important to exclude opacity of the cornea, aqueous humor, and lens. Then, after dilating the pupil, the vitreous should be examined carefully with a +8 D lens behind the ophthalmoscope. In this way the diffuse haze may resolve itself into fine dust-like particles or shreds of membranes. Again, it is often extremely difficult to differentiate between slight diffuse opacity of the vitreous and haziness of the retina due to edema. In making a diagnosis it is well to remember that in opacity of the vitreous the *light streak* on the retinal vessels is comparatively *well marked*, while in haziness of the retina it is *diminished* or *absent.*

Movable Opacities of the Vitreous.—These may be of any size or shape and usually gravitate to the lower part of the vitreous chamber. In order to see them the patient is directed to look quickly upward, then downward, and

finally straight in front of him; these movements will stir up any opacities and cause them to float across the pupillary space. A close examination will show that many of these floating opacities are attached by filamentary bands to some peripheric portion of the fundus. *Hemorrhages* from the vessels of the uvea or retina into the vitreous, either spontaneous or as a result of injuries, may be so extensive as to cut off even the faintest glim-

FIG. 26.—BLOOD-VESSELS IN THE VITREOUS.—(*Nettleship.*)

mer of the fundus. The same black appearance of the pupil is also found as a result of *intraocular tumors* and *purulent exudations* into the vitreous. If these dense opacities lie in the anterior part of the vitreous, their color and shape may be observed with oblique illumination.

Fixed Opacities of the Vitreous.—These, like movable opacities, may be of any size and shape and appear as

black points or bodies suspended in the vitreous. Sometimes delicate gauze-like membranes or brilliant white bands covered with small new-formed vessels (Fig. 26) are seen to stretch across the vitreous (retinitis proliferans). (See page 137.)

To Determine the Position of any Fixed Opacity.—A fixed opacity may lie in the cornea, lens, or vitreous

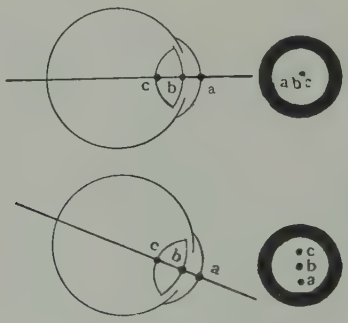

FIG. 27.—TO DETERMINE THE POSITION OF A FIXED OPACITY IN THE EYE.

In the upper drawing is shown an opacity on the cornea at a, one on the anterior surface of the lens at b, and one on the posterior surface at c. Looking into the eye, these three opacities appear as one black point in the center of the pupil. If the patient is now requested to look down, three black points appear. c moves upward, b remains stationary, and a moves downward.

humor, and as the center of motion of the eye is in the vitreous, an opacity lying in front of the center will, when the eye moves, move in the same direction, while one seated behind the center will move in the opposite direction. The closer the opacity is to the center, the less extensive the movement (Fig. 27). For example, if we examine the eye with the ophthalmoscope at a short dis-

tance and direct the patient to look upward, an opacity in the cornea will move rapidly upward and out of the pupillary space; one deep in the vitreous will move as rapidly downward and pass behind the border of the iris. If the movement is restricted, the opacity is in the lens,

BLOOD-VESSELS IN THE VITREOUS.

This new blood-vessel formation is situated well forward in the vitreous and springs from three vessels which can be traced back to the optic disc.

and one on the anterior surface will move upward, while an opacity at the posterior pole of the lens will *appear* to move downward, because, although the opacity is in front of the center of motion, we get the effect of a downward movement from the great displacement of the iris upward.

CHAPTER IV.

THE NORMAL FUNDUS.

The Normal Fundus.—The "fundus" is a term used to denote the inner surface of the posterior half of the globe. The ophthalmoscopic picture of the fundus is largely due to the choroid modified somewhat by the sclerotic and retina.

The Sclerotic. — The sclerotic is covered by the nearly opaque choroid, and is therefore never seen in healthy eyes. In the albino, where the pigment of the retina and choroid is absent, it appears as a pinkish-white background upon which the interlacing meshes of the choroidal vessels are seen in great detail. When the choroid is destroyed by disease or is absent as in coloboma, the sclerotic appears as a brilliant white or bluish-white surface, easily to be distinguished from the dull dead white patches of inflammatory exudation.

The Choroid.—The choroid is a membrane from 0.08 to 0.16 millimeters thick, composed chiefly of blood-vessels arranged in groups, the larger ones externally and the finer ones internally (Fig. 28). The vessels are supported by a web of connective tissue and elastic fibers, in which are found numerous star-shaped pigment cells. The amount of pigment varies in different individuals, but is always most abundant among the larger vessels of the outer layer.

Color of the Fundus.—The normal fundus or background of the eye owes its red or ochre-red color to the blood circulating in the choroidal vessels and especially in the capillaries. The color of the fundus varies greatly in shade according to the complexion of the individual. It never assumes the color of the blood itself, as seen in the retinal vessels, because it is modified (1) by the

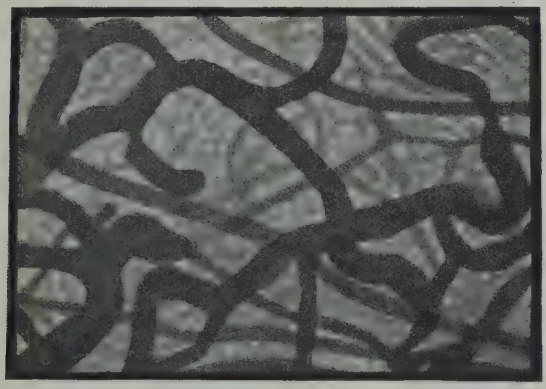

FIG. 28.—CHOROIDAL VESSELS.

The veins are large, dark, and tortuous; the arteries, smaller, lighter, and straighter; the capillaries are faintly outlined in the background. —(*Alt.*)

single layer of hexagonal pigment cells of the retina, (2) by the pigment contained in the stroma, and (3) by a certain amount of white light reflected from the sclerotic.

Color of the Fundus in Fair Eyes.—Here the pigment is but moderate in amount and the fundus appears of a delicate pink or orange-red color, with the choroidal vessels exposed over one or more sectors, especially at

the periphery. In many fair eyes, however, the choroidal vessels are but faintly outlined and the fundus presents the uniform red color as seen in persons with the average amount of pigment.

Color of the Fundus in Dark Eyes.—This is, as a rule, of a uniform deep red, with only a trace of the choroidal vessels showing in the periphery. Usually the retinal and choroidal pigment corresponds in amount,

FIG. 29.—CHOROID TIGRE.

and the choroidal vessels are seen on a somewhat lighter background. If the retinal pigment is thin, while the choroid is deeply pigmented, the large choroidal vessels appear with dark-colored interspaces, giving a peculiar striped appearance resembling the markings of a tiger's skin (choroid tigre) (Fig. 29). It is to be distinguished from abnormal displacements of pigment by its regularity of design and its sharp outline.

Color of the Fundus in the Negro.—Here the pigment is so abundant that the choroidal vessels are invisible and the whole fundus has a slaty, grayish hue, or even a silvery white appearance, with little or no red tinge in it. The retina appears as a gray veil, most marked above and below the disc. A mydriatic is often required in order to get a satisfactory view of a dark fundus.

Color of Various Areas of the Fundus.—From an unequal distribution of pigment the fundus is rarely of a uniform color throughout, being darkest in the macula region and lightest in the periphery and immediately around the disc.

Color of the Fundus as Affected by the Light Employed.—The color of the fundus is also modified by the quality and quantity of the light. With ordinary daylight the fundus appears of a delicate rose-pink; with a white light (electric or Welsbach) it is of a less vivid red than when gas is used. It is also to be remembered that the stronger the illumination, the more pronounced the red of the fundus; hence it is of a deeper red with the indirect than with the direct method.

Texture of the Fundus.—This varies much, being smooth and fresh-looking in the young, and more or less granular in the adult. In dark eyes the retinal pigment is often visible as a very fine stippling, while in some fair eyes it gives the fundus an appearance as if peppered over with fine granules of gunpowder.

The Choroidal Vessels.—These are best studied in fair eyes and at the periphery of the fundus (Fig. 30). They are never seen in the macula region on account of its abundant pigmentation. They are flat, tape-like or

ribbon-like bands, of lighter color, of larger size, and less distinctly seen than the retinal vessels, and so nu-

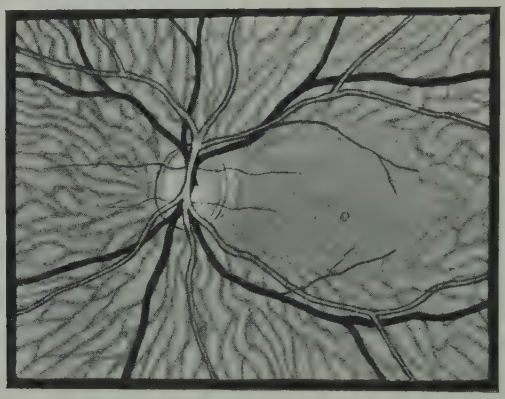

FIG. 30.—CHOROIDAL VESSELS, VERY LIGHT FUNDUS.

FIG. 31.—VORTICOSE VEIN.—(*Alt.*)

merous and so close together that the interspaces are often narrower than the vessels. They are of uniform

size from center to periphery, have no central light streak, and lie behind the retinal vessels. They run a more or less parallel course and frequently anastomose, resembling a piece of sea-tangle. The arteries of the choroid cannot be distinguished from the veins. Near the equator they radiate toward a common center to form the four or five vorticose veins (Fig. 31).

The Optic Disc, Nerve-head, or Papilla.—The most conspicuous landmark of the fundus, and the one to which every observer first directs his attention, is the nerve-head with its branching central artery and vein. It is situated a little to the nasal side of the posterior pole of the eye and appears as a whitish disc, closely encircled by the red choroid.

Shape of the Disc.—The disc is nearly round or slightly oval (as 9 is to 7½), with its long axis vertical. In some cases the long axis is oblique or even horizontal, and in rare instances the disc may be twice as long as it is broad. The oval disc due to astigmatism is to be distinguished from the normal oval by the fact that, with the indirect method, it alters its shape as the objective is gradually withdrawn and fails to do so when the optical error is corrected. For example, in a case of simple hypermetropic astigmatism corrected by + 5.00 D cyl. ax. 85°, the disc alters from a horizontal to a perpendicular oval as the object glass is withdrawn.

Size of the Disc.—The average diameter of the optic disc is about 1.4 millimeters, and as the ophthalmoscope magnifies objects 14⅓ times, its apparent diameter is 20 millimeters. To most observers the disc appears smaller than this,—about 12 millimeters,—from the fact that an

object in close proximity to the eye, and which cannot be compared with anything else, appears smaller than it really is.

Level of the Disc.—The optic disc projects slightly above the level of the fundus, hence its name papilla, although to the casual observer it appears to lie in the same plane. This is due to the fact that the optic nerve-fibers anterior to the lamina cribrosa are without a medullary sheath, and, being transparent, all that is seen is the white disc at a lower level made up of nerve-fibers with their sheaths and the interlacing fibers of the lamina cribrosa. That the real level is above this is shown on close inspection, first, by the presence of a fine gauzy veil, and second, by the position of the vessels which spring forward from the center of the disc. These vessels, which *are always supported on the disc surface*, may be seen to move across and considerably in front of the white disc when the observer moves his head and mirror slightly from side to side.

Color of the Disc.—The color of the disc may vary from a rosy pink to a rich red, but in health always presents a marked contrast to the red of the fundus. The variations in color depend upon the transparency of the nerve-fibers ; this is less when the capillary circulation is rich and the connective-tissue elements abundant. In fair eyes the nerve-fibers are more transparent and the disc has a pinkish tint ; in dark eyes the fibers are usually less transparent and the disc appears of a deeper red. In young people with dark eyes the abundance of connective tissue may give to the disc a more opaque, dull red, and striated appearance simulating congestion or inflammation.

Detailed Study of the Disc.—A close inspection shows that the disc may be divided into several parts, each of which differs from the other in color and texture (Fig. 32).

The Porus Opticus.—Sometimes the connective-tissue sheath, instead of closely embracing the vessels, as it is apt to do in early life, presents a funnel-like opening, so that the vessels can be traced a short distance into the nerve, although not down to the lamina cribrosa. This depression is called the porus opticus.

The Physiologic Cup.—Usually, however, the separation of the optic nerve-fibers to radiate into the retina exposes to view a portion of the lamina cribrosa and leaves a central hollow about one-half the size of the disc, known as the physiologic cup. This central depression is usually white and is always much paler than the periphery, because it contains fewer nerve-fibers and is therefore less vascular. Physiologic cups vary in size, depth, and position, owing to the arrangement of the nerve-fibers. These are massed most abundantly above and below and to the nasal side, so that the cup is apt to present a steep edge on the nasal side, while on the temporal, the floor slopes up gradually to the margin of the disc. The vessels follow the walls of the cup, often dipping down abruptly out of sight to reappear out of focus on the floor of the cup. A physiologic cup may have steep walls and even overhanging edges, but it *never involves the whole disc.* This important characteristic distinguishes it from a pathologic cup which involves the *entire extent* of the disc.

Parallactic Movement.—When cupping is present,

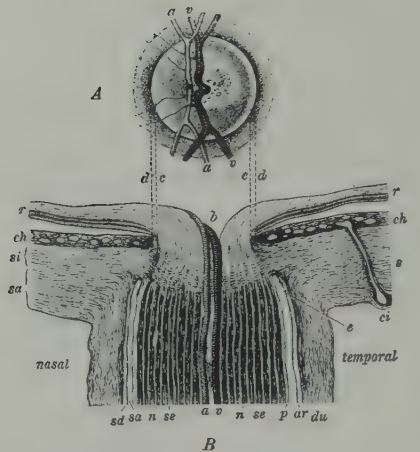

FIG 32.—HEAD OF THE OPTIC NERVE.

A, Ophthalmoscopic view: Somewhat to the inner side of the center of the papilla the central artery rises from below, and to the temporal side of it rises the central vein. To the temporal side of the latter lies the small physiologic excavation with the gray stippling of the lamina cribrosa. The papilla is encircled by the light scleral ring (between *c* and *d*), and the dark choroidal ring at *d*. *B*, Longitudinal section through the head of the optic nerve: Magnified 14 × 1. The trunk of the nerve up to the lamina cribrosa has a dark color because it consists of medullated nerve-fibers, *n*, which have been stained black by Weigert's method. The clear interspaces, *se*, separating them, correspond to the septa composed of connective tissue. The nerve-trunk is enveloped by the sheath of pia mater, *p*, the arachnoid sheath, *ar*, and the sheath of dura mater, *du*. There is a free interspace remaining between the sheaths, consisting of the subdural space, *sd*, and the subarachnoid space, *sa*. Both spaces have a blind ending in the sclera at *e*. The sheath of dura mater passes into the external layers, *sa*, of the sclera, the sheath of pia mater into the internal layers, *si*, which latter extend as the lamina cribrosa transversely across the course of the optic nerve. The nerve is represented in front of the lamina as of light color, because here it consists of non-medullated and hence transparent nerve-fibers. The optic nerve spreads out upon the retina, *r*, in such a way that in its center there is produced a funnel-shaped depression, the vascular funnel, *b*, on whose inner wall the central artery, *a*, and the central vein, *v*, ascend. The choroid, *ch*, shows a transverse section of its numerous blood-vessels, and toward the retina a dark line, the pigment epithelium; next the margin of the foramen for the optic nerve, and corresponding to the situation of the choroidal ring, the choroid is more darkly pigmented. *ci* is a posterior short ciliary artery which reaches the choroid through the sclera. Between the edge of the choroid, *d*, and the margin of the head of the optic nerve, *c*, there is a narrow interspace in which the sclera lies exposed, and which corresponds to the scleral ring visible by the ophthalmoscope.—(*Description and figure from Fuchs.*)

differences in level may be recognized by the parallax test; *e. g.*, with the *direct method*, as the ophthalmoscope is moved slightly from side to side, the bottom of the cup appears to move in the same direction, while the edge of the disc remains almost stationary. With *the indirect* method the edge of the disc appears to slide over the bottom of the cup (Fig. 33).

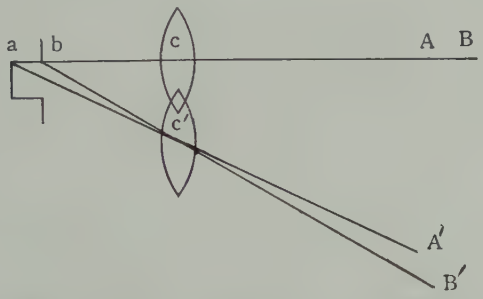

FIG. 33.—PARALLACTIC DISPLACEMENT OF THE INVERTED IMAGE. Let b represent the edge and a the bottom of an excavation of the optic nerve. Seen through the lens, c, a, and b cover each other at A B. If the lens is now moved to c′, the image of the points a and b appears to have separated to A′ B′.

To Estimate the Depth of the Cup.—First estimate the refraction at the edge of the disc and then at the bottom. The difference will represent the depth of the cup. 3 D = 1 mm.

The Lamina Cribrosa.—This is the sieve-like continuation of the sclerotic across the space through which the optic nerve enters the eye. It is seen at the bottom of a cup as a brilliant white tissue mottled by gray spots corresponding to the openings of the nerve-fibers. In the normal condition the translucent nerve tissue, which

is of a reddish color, hides from view the greater part of the lamina cribrosa, although the latter always reflects a certain amount of white light.

The Nerve-fiber Zone.—Encircling the white connective-tissue string and the physiologic cup is a zone made up of the whole mass of nerve-fibers, permeated by a plexus of fine blood-vessels, which gives to the disc its more or less rosy pink color. The color is more intense above, below, and to the nasal side, owing to the massing of the nerve-fibers in those situations. The nerve-fiber zone is most affected by diseased conditions, and therefore merits the closest study.

Scleral Ring.—This is a narrow white band encircling the nerve-fiber zone which indicates the rim of the sclerotic exposed within the choroidal ring. According to Loring, this fine white ring is formed from the pial sheath of the nerve. The scleral ring is not of a uniform diameter, being narrow or absent above and to the nasal side, and forming a more or less broad crescent below or to the outer side. Occasionally it is very broad, encroaching upon the disc or even upon the choroid (congenital crescent of the disc), and might easily be mistaken for atrophy of the nerve. The scleral ring is well marked in many cases of myopia, appearing as a crescent to the temporal side of the disc, more rarely completely encircling it. In some cases the normal eye presents a small white crescent at the temporal edge of the disc, due to a drawing aside of the choroid. It can only be distinguished from the crescent of myopia by the absence of that defect.

The Choroidal or Pigment Ring.—This lies just out-

side of the scleral or connective-tissue ring and forms the boundary of the disc. The amount of pigment varies greatly, from a faint line to (in rare cases) a broad band completely encircling the disc. The pigment ring is more marked in young eyes, but is rarely complete; often only a small amount of pigment is found at the sides of the disc.

The Margin of the Disc.—The edges of the disc should be clearly defined, though in young eyes they are often softened by a gauzy film, which is especially marked above and below and due to reflection of light from the nerve-fibers. This striated appearance must not be confounded with blurring of the disc due to swelling in optic neuritis. When in doubt, the disc should be observed under moderate illumination and carefully compared with that of the other eye.

The Retina.—Although the retina is a membrane of considerable thickness, it is not usually visible, on account of its transparency. Sometimes, as the light strikes the fundus at a certain angle, the presence of the retina is indicated by a gray, gauzy film and a radiating fine striation most marked in dark eyes and in the neighborhood of the disc. The retinal vessels, which ramify in the nerve-fiber layer, appear to lie on the surface of the red choroid. If, however, a main branch of the central artery as it curves over the edge of the disc is accurately focused, and the head moved slightly from side to side, the observer is often able to appreciate the fact that the vessel lies in a plane considerably anterior to the white of the disc and the surrounding choroid. The same effect is obtained if a retinal vessel is observed as it crosses a patch of choroidal atrophy.

The Retinal Reflex (*Shot-silk Appearance*).—In children, especially of dark complexion and hypermetropic refraction, vivid reflexes often exist which show a tendency to run along and over the blood-vessels in the neighborhood of the disc and shift from one part to another with every movement of the mirror. They are most distinct when the pupil is undilated. Sometimes they extend over the whole fundus, radiating from the disc in lines of a silvery or metallic luster. This is the so-called "watered" or "shot-silk" appearance, and is never observed in the adult. The retinal reflex is supposed to be due to irregularities in the surface caused by slight folding of the retina persisting after birth. The shadows thrown on the retina when a wisp of the patient's hair comes between the light and the mirror must not be mistaken for a retinal reflex.

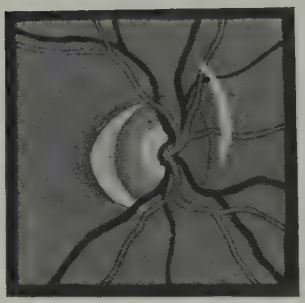

FIG. 34.—THE WEISS REFLEX. A narrow band of light in front of the vessels seen close to the nasal edge of the disc, but not so conspicuous as is shown in the drawing.

The Weiss Reflex.—This consists of a crescent-shaped reflex situated a little to the nasal side of the disc (Fig. 34). It indicates swelling of the disc, and by some is considered an evidence of progressive myopia.

Vessels of the Retina.—The retinal vessels can readily be distinguished into arteries and veins by their color, the arteries being of a lighter red than the veins. The smaller arteries and veins are more alike in color, so

that in order to differentiate it may be necessary to trace the vessel back to a larger trunk. The central artery and vein emerge from near the center of the disc, the artery usually to the nasal side of the vein, and divide in one of several ways: (1) The first division takes place in the nerve and the vessels appear as a superior and inferior artery and a superior and inferior vein. (2) The artery and vein emerge from the floor of the disc each as a single vessel and divide upon the surface of the disc, so that the branches make a sudden bend at right angles to the parent stem, which they often conceal. (3) The vein divides into an upper and lower branch in the nerve, while the division of the artery takes place upon the surface of the disc or *vice versa*. The vessels usually follow the walls of the physiologic cup and pass over the disc margin in gentle curves. If the cup is large, the vessels are displaced to the nasal side. The upper and lower trunks divide on the disc or near it into an inner and outer branch, which, from the course they take, are named superior temporal and nasal, and inferior temporal and nasal. All undergo further subdivision and ramify over the fundus in an arborescent manner, diminishing in caliber as they extend toward the periphery (Fig. 35). The temporal vessels are larger than the nasal, and as they arch above and below the macula region, give off fine twigs which, by the direct method, may be traced to within a short distance of the fovea centralis. The fine twigs are difficult to see because the color of the macula approaches more nearly that of the blood. Small, single vessels, branches of the main trunk, emerge from different parts of the

disc and pass in various directions, most frequently toward the macula.

Cilioretinal Vessels.—A single vessel, sometimes of large size, is often seen emerging on the temporal edge of the disc and coursing outward like a branch of the central artery (Fig. 37). It is often possible to trace this vessel backward a little into the substance of the nerve, when it will be found to curve peripherally,

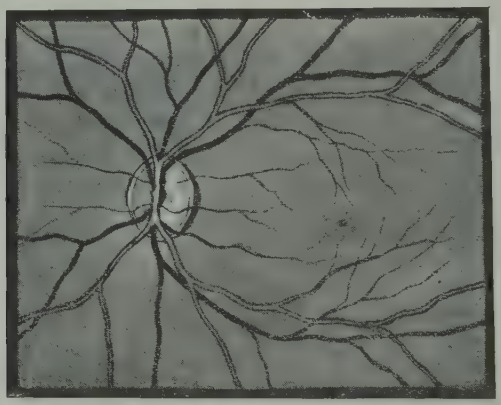

FIG. 35.—NORMAL DISTRIBUTION OF RETINAL VESSELS.

showing that it is not a branch of the central artery, but of a posterior ciliary vessel (cilioretinal vessel). In case of embolism such a vessel may keep intact a portion of the retina.

Diameter of the Retinal Vessels.—With the ophthalmoscope the retinal vessels appear of considerable size, but in reality are exceedingly small, the largest being less than $\frac{1}{100}$ inch in diameter, and the smallest not

more than $\frac{1}{700}$ inch. The retinal capillaries are invisible. The largest diameter of the vessel is usually on the floor of the disc, but frequently a vein, more rarely an artery, will be found thicker in the neighborhood of the disc than on the disc itself. The relative size of the

FIG. 36. FIG. 37.

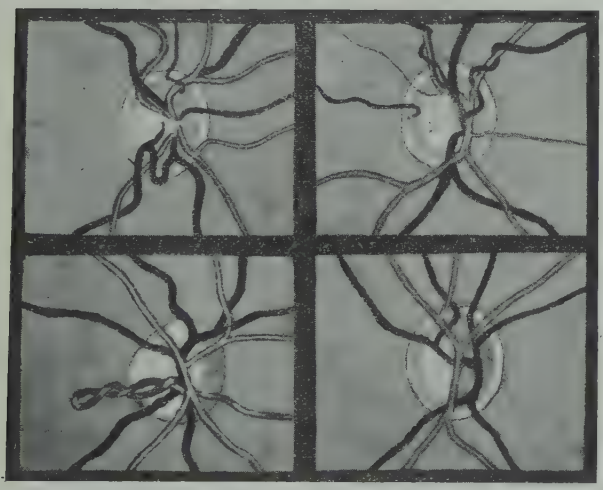

FIG. 38. FIG. 39.

Fig. 36, Bifurcating retinal veins. Fig. 37, Corkscrew twist of retinal veins and a cilioretinal vessel. Fig. 38, Vein twisting upon itself and projecting into the vitreous. Fig. 39, Abnormality of retinal veins.

arteries and veins varies much in different cases. If two arteries accompany one vein, the arteries are apt to be much smaller than the vein, and *vice versa*. But as a rule, where a single artery and vein run side by side, the artery will be one-third smaller than the vein.

Tortuosity of the Retinal Vessels.—The vessels of the retina run a serpentine course, and while the veins take the same general direction as the arteries, they are usually more tortuous. Frequently an artery and its corresponding vein cross and recross, the artery usually

Fig. 40.—Tortuous Veins.

being in front of the vein. It is rare to find an artery crossing an artery or a vein a vein. In some instances, even in health, the arteries and veins may be very tortuous (Fig. 40); a single vessel, usually a vein, may present a series of twists like a corkscrew, or a vein may be twisted around an artery (Fig. 37); rarely, one

vessel may double upon itself like the twist of a rope (Fig. 38); occasionally, a vein, as it approaches the disc, bifurcates (Fig. 36), or a vein on the disc may circle around and receive most of the others (Fig. 39). Tortuosity of the vessels is most frequently seen in hypermetropic eyes. The distribution of the retinal vessels is much alike in both eyes; hence, in determining whether the tortuosity is physiologic or pathologic, it is well to compare one eye with the other. Moreover, when physiologic, the tortuosity is nearly always lateral, while when pathologic it has an anterior posterior bend.

Walls of the Retinal Vessels.—The walls of the retinal vessels are transparent and for the most part invisible. What we really see is the column of blood within, as is shown by the fact that when a vessel is emptied by pressure on the globe it disappears from view. Sometimes, but only by the direct method, the walls of the larger branches on or near the disc appear as white translucent lines along the sides of the blood column. This is most distinct where one vessel crosses another and when viewed by feeble illumination. These faint white lines must not be confounded with the various retinal reflexes. Conspicuous white lines along the retinal vessels are a sign of disease.

The Light Streak.—This is a luminous band, about one-third the diameter of the vessel, which runs down the center of both arteries and veins, and is probably a reflection from the anterior surface of the column of blood. This central reflection or light streak is distinct when the vessel lies in the same plane as the retina and disappears when the vessel takes an antero-posterior

curve. The light streak is less marked on the veins, and according to Loring its brilliancy is dulled and its diameter reduced when the circulation is retarded.

Pulsation of the Retinal Veins.—Pulsation is very frequently observed in one or more veins just at the point where it curls over the edge of the physiologic cup. This alternate contraction and dilation of the vein resembles the to-and-fro action of a piston, and is synchronous with the systole of the heart. It is the result of a momentary increase of the intraocular tension at the height of the arterial pulse-wave. When the venous pulse is not present, it may be produced by slight pressure on the globe.

Pulsation of the Retinal Arteries.—This never occurs in health. It is seen in glaucoma from increased tension and in aortic regurgitation from diminished propelling power. It is artificially produced by strong pressure on the globe. An apparent pulsation of the artery is sometimes caused by contact with a pulsating vein. The arterial pulse is a sudden or jerky disappearance and reappearance of a portion of a vessel on the disc, though often extending some distance on the retina.

The Macula Region.—The macula lutea, or yellow spot, so called from a transient appearance it presents after death, is a shallow depression situated to the temporal side of the disc at about two discs' diameter from its lower margin. In the center of the macula is a slightly deeper depression termed the fovea centralis. With the *indirect method* the macula appears as a dark area often surrounded by a luminous ring, but otherwise presenting no distinctive features. With the *direct*

method it appears of a darker red than the rest of the fundus and has a fine pigment stippling or granular appearance due to the irregular distribution of the retinal pigment. In its center, corresponding to the situation of the fovea, is a bright point. In some light eyes this darker area is wanting, and the fovea alone is marked by a bright point or a small dark granular spot. The blood-vessels which arch above and below the macula send off fine twigs which approach very near to the fovea.

Macula Reflexes.—With the *indirect method* this reflex consists of a silvery ring or horizontal oval, about the size of the disc, enclosing a space of a grayish or brownish color (Fig. 41). Sometimes the fovea is seen as a bright point. With the *direct method*, the silvery ring or reflex of the macula, noticed by the indirect method, is much less marked or may be absent.

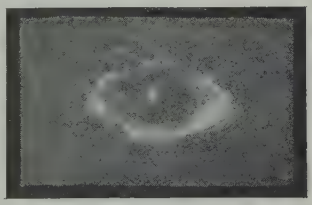

FIG. 41.—MACULA REFLEXES.

In many cases only a sector of the reflex is observed, which shifts its position with the movements of the mirror. A more conspicuous reflex than the above is almost always present at the fovea. It is a minute crescent of light which travels from side to side of the depression as the mirror is moved. Sometimes it has the appearance of a beam of light projected from the bottom of the depression (policeman's lantern reflex). The ophthalmoscopic examination of the macula region is often difficult from

corneal reflexes and contraction of the pupil. The use of a mydriatic renders the examination easy.

The Fundus of the Young Eye.—This is a vivid red and presents a peculiarly fresh and brilliant appearance. The transparent tissues throw out glittering reflexes along and over the vessels and around the macula region, which shift with every movement of the mirror. The pigment ring is often well marked, and the reddish tinge of the disc may simulate hyperemia.

The fundus of the adult eye is of a less vivid red, the tissue less transparent and of a more granular appearance, and usually free from reflections. The nerve is paler and often has ragged edges, with atrophic changes in the surrounding choroid. The vessels appear slightly smaller and the light streak is less marked.

The fundus in myopia appears bright and the choroidal vessels are apt to be exposed. The choroid near the disc on the temporal side may be atrophic and the seat of a more or less extensive posterior staphyloma. With the *indirect method* the disc and vessels appear smaller than in the normal eye, while with the *direct method* they appear larger.

The Fundus in Hypermetropia. — Owing to the greater amount of connective tissue the retina throws out glittering reflections and has a striated appearance. This may slightly obscure the disc and lead the inexperienced observer to the diagnosis of optic neuritis. With the *indirect method* the disc and vessels appear larger than in the normal eye, while with the *direct method* they appear smaller.

The Fundus in Astigmatism.—With the *indirect*

method all the details of the fundus will appear clear and well defined, but the disc may undergo more or less change in shape, as the object glass is withdrawn. With the *direct method* the details of the fundus appear indistinct and the disc out of shape, and while the vessels in one meridian are seen clearly, those in the opposite meridian appear out of focus. This condition should not be taken for optic neuritis. In low degrees of astigmatism the above appearances are not well marked and may easily escape notice.

CHAPTER V.

CONGENITAL ANOMALIES.

Albinism, or absence of the physiologic pigment, is congenital and often inherited. The iris has a pink appearance due to reflection of light from its own blood-vessels and from those of the choroid. With the ophthalmoscope the interlacing meshes of the choroidal vessels are seen in great detail on a white background (Fig. 30). Albinism is most marked in childhood and is accompanied by nystagmus, strabismus, amblyopia, and high degrees of refractive defects.

Treatment.—Often considerable improvement follows the use of blue glasses ground so as to correct the refractive error.

Pigmentation of the Choroid.—Frequently irregular patches or isolated dots of pigment are found in the neighborhood of the disc, usually to the temporal side. In rare cases groups of brown or black pigment dots, of an angular or irregular shape, are observed on a sector of the fundus, which otherwise appears perfectly normal (Fig. 42). Vision is not impaired.

Coloboma of the Choroid.—This is due to incomplete closure of the fetal cleft and is frequently associated with the same defect in the iris, ciliary body, and occasionally in the lens. The defect may occur in one or both eyes, is often inherited, and is usually accompanied by myopia,

amblyopia, or microphthalmus. The coloboma consists of a circumscribed defect in the choroid, of a brilliant white color from exposure of the sclerotic (Fig. 43). It is of oval shape, sharply defined, and, beginning usually a short distance below the disc, extends directly or obliquely downward, often as far as the eye can follow. A part or the whole of the optic disc may be included

FIG. 42.—PIGMENTATION OF THE CHOROID.—(*After Stephenson.*)

in the coloboma, in which case its position is only recognized as the meeting-point of the retinal vessels. The coloboma usually bulges outward and the surface of the depression is divided by prominent ridges into several compartments, which may vary in color from white to bluish-green. The larger retinal vessels rarely cross the coloboma, but on reaching the edge run along its borders. The small retinal, choroidal, and ciliary vessels

run across its surface in a very irregular and tortuous manner, and are with difficulty distinguished one from the other. The disc takes the form of a horizontal oval with a downward inclination, probably from stretching and bulging of the sclerotic. Occasionally the retina extends across the coloboma, but, as a rule, both retina and choroid are absent within the defective area. In

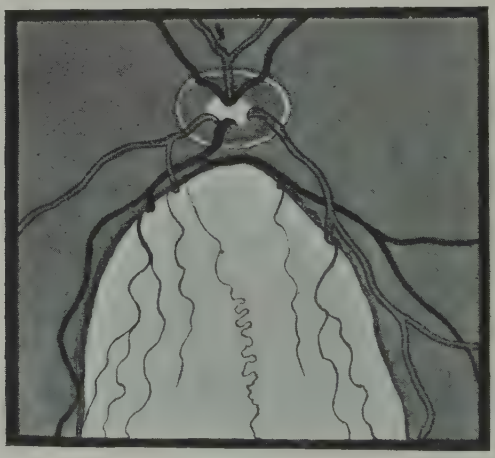

FIG. 43.—COLOBOMA OF THE CHOROID.

most cases pigment is heaped along the borders of the coloboma and found upon its surface. There is a defect in the visual field corresponding to the coloboma, and central vision is much diminished from faulty development of the whole eye.

Coloboma of the Macula.—This is a rare anomaly and consists of a more or less circular defect of the choroid, somewhat larger than the disc, situated in the

macula region (Fig. 44). It is free from pigment, bulges backward, and shows traces of choroidal vessels on the white surface of the depression. Central vision is very much reduced or entirely wanting. This condition may be mistaken for an atrophic spot, the result of hemorrhage, or for the remains of an intra-uterine inflammation.

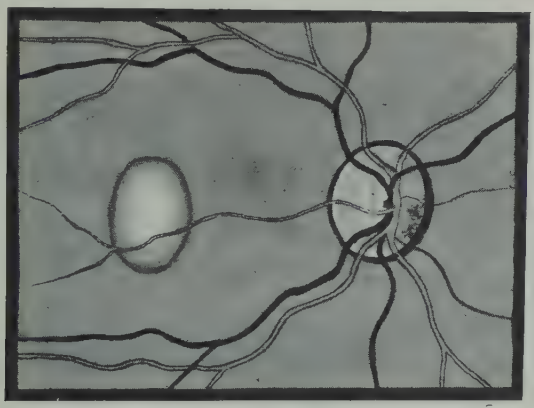

FIG. 44.—COLOBOMA OF THE MACULA; ALSO PIGMENT ON THE DISC AND UNUSUALLY WELL-MARKED CHOROIDAL RING.

Pigment on the Disc.—Isolated dots or small patches of free pigment are sometimes found on the surface of the disc. They are of choroidal origin and should not be confounded with the pigment remains of hemorrhage or other morbid processes. Occasionally the choroidal ring is conspicuous as a broad black band surrounding the disc (Fig. 44), and sometimes this choroidal pigment is seen to cover a portion of the disc.

Congenital Crescent of the Disc.—This is quite a

common defect, and, according to Frost, is due to an uneven distribution of the tissue of the lamina cribrosa. It consists of a whitish crescent of more or less extent, with the broad part downward, situated usually at the lower border of the disc (Figs. 45 and 46). It is a part of the disc and thus differs from a myopic crescent, which is formed from exposure of the sclerotic. The red of the disc is darker than usual, from packing together of the nerve-fibers. The physiologic cup is

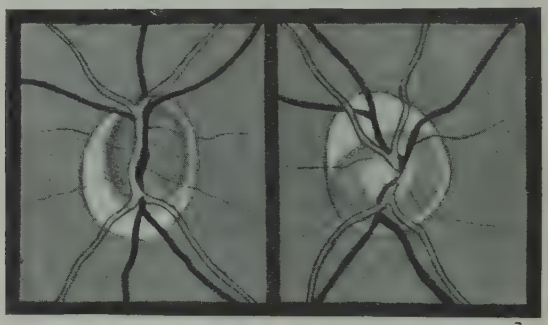

FIG. 45. FIG. 46.

FIGS. 45, 46.—CONGENITAL CRESCENT OF THE DISC.

often absent; if present, its steep edge is situated above instead of to the nasal side. Astigmatism is usually present and vision may be below normal.

Coloboma of the Disc.—This rare anomaly is due to imperfect closure of the fetal cleft and may occur without involvement of the choroid. Coloboma of the disc varies much in size and appearance, but in most cases the disc area is enlarged to two or three times its normal size, and presents a deep excavation with a glitter-

ing white or bluish-white floor (Fig. 47). Sometimes the coloboma is funnel-shaped and so deep that the floor is invisible. The retinal vessels curl abruptly over the edge and are lost to view in the depression. In a case reported by Dr. Randall (Fig. 48), the disc was twice the normal diameter and depressed 6 D. In the lower and inner part of this was a circular pit 4 D deeper than the main depression. Very deep funnel-shaped excavations are sometimes seen occupying but a small part of

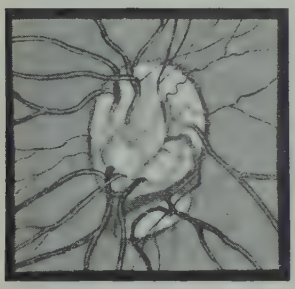

FIG. 47.—COLOBOMA OF THE DISC.—(*Benson.*)

FIG. 48.—COLOBOMA OF THE DISC.—(*Randall.*)

an otherwise normal disc. Partial coloboma of the disc, congenital crescents, and abnormally developed connective-tissue ring present many features in common.

Congenital Cupping of the Disc.—This has occasionally been observed so extensive as to resemble the cupping of glaucoma. In a case reported by Loring (Fig. 49), it was decided to be congenital from the fact that the excavation did not extend at any part to the edge of the disc. The cup had a sharp edge, not rounded as in glaucoma, and several of the vessels

pierced the border. There was no pulsation in either veins or arteries; vision and field were normal, and the defect was found in the other eye, and in both eyes of her daughter.

Congenital Elevation of the Disc.—In rare cases the disc is the seat of a mound-like swelling so extensive as to present many of the characteristics of optic neuritis. In a case under observation the disc is elevated 6 D above the surrounding fundus, but its congenital

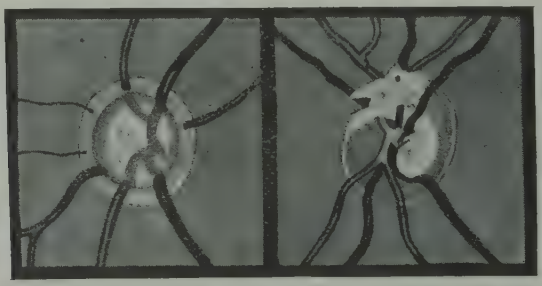

FIG. 49.—CONGENITAL CUPPING OF THE DISC. FIG. 50.—CONNECTIVE TISSUE ON THE DISC.

nature is evident from the fact that it has remained stationary for five years, and the vision and field are normal.

Connective Tissue on the Disc.—Peculiar gauzy white films, delicate shreds, or irregular white patches are sometimes observed which more or less obscure the vessels on the disc (Fig. 50). When congenital, the vessels are *merely concealed;* when the result of disease, the vessels are *constricted.*

Opaque Nerve-fibers.—The opaque medullary

sheath of the optic nerve-fibers is discarded at the lamina cribrosa, from which point they pass on as transparent fibers. In the case of opaque nerve-fibers, the medullary sheath is retained over the affected area. The opaque fibers appear as a brilliant white patch, or patches, with sometimes a bluish or greenish tinge, usually situated at the upper and lower margins of the disc. The

FIG. 51.—OPAQUE NERVE-FIBERS.

patches extend a short distance onto the retina and terminate in brush-like or feathery ends (Fig. 51). Occasionally a part or the whole of the disc is hidden, and when the patches extend a long way over the retina they usually follow the course of the temporal vessels. Rarely, isolated patches are seen at some distance from the disc. The retinal vessels are more or less concealed by the opaque fibers, but after emerging from the edge

of the patch they pass on in a normal manner. Vision is not affected, though the blind spot is increased, corresponding to the defect. Opaque nerve-fibers should not be confounded with the striated appearance of the disc margin so frequently seen in young people of dark complexion, nor with choroidal atrophy, which has a grayish or greenish-white tint and is always associated with more or less disturbance of pigment.

Persistent Hyaloid Artery.—In embryonic life the hyaloid artery runs from the disc through the central canal of the vitreous (Cloquet's canal) to the posterior surface of the lens. This vessel disappears usually before or shortly after birth, but sometimes persists in after life, and then is often associated with posterior polar cataract and other congenital arrests of development. It appears as a black or grayish string starting from the central portion of the disc, and is either attached to the lens or more frequently stops short of this and ends in a flattened head which floats about in the vitreous (Fig. 52). Usually the vessel does not contain blood.

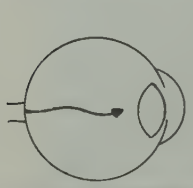

FIG. 52. — PERSISTENT HYALOID ARTERY.

Cloquet's Canal.—This is the lymph space in which the hyaloid artery lies. It persists throughout life, but usually is not visible on account of its transparency. Occasionally it is translucent, and then appears as a gauzy white string attached to the central part of the disc by a spindle-shaped enlargement (Fig. 53). It floats about in the vitreous much the same as a persistent hyaloid artery. It should be differentiated from

string-like connective-tissue formations, the result of hemorrhages or other morbid processes.

Punctate Conditions of the Fundus.—A careful examination of the fundus will very frequently reveal one or more minute, glistening, pale yellow or white dots situated in the macula region or scattered over the

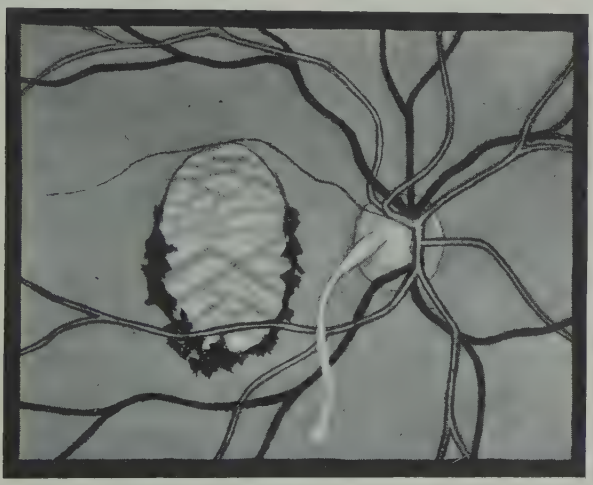

FIG. 53.—CLOQUET'S CANAL AND CENTRAL CHOROIDITIS (CONGENITAL?).

fundus. They are of retinal or choroidal origin, very often congenital, and rarely affect vision.

Gunn's Dots.—These consist of one or more minute, pale or yellowish dots in the neighborhood of the macula region. They are very difficult to see, and then only as the light is shifted over them with the movements of the mirror. They occur chiefly in young patients, often with symptoms of asthenopia.

Nettleship's Dots.—This is a rare condition and consists of numerous minute, round, dead white dots uniformly scattered over the fundus (Fig. 54). It has been observed in several members of the same family, and is associated with pigment changes at the periphery and night-blindness. According to Nettleship, the condition is the same as that described by Mooren as retinitis punctata albescens.

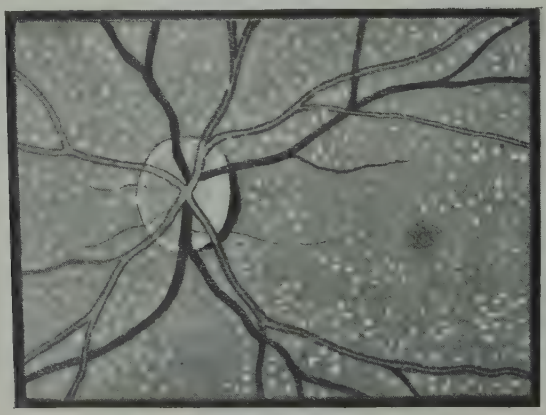

FIG. 54.—NETTLESHIP'S DOTS.

Metallic Dots.—Occasionally, one or more minute isolated dots of metallic luster are observed which are conspicuous from their brightness. They may occur in any part of the fundus, but nothing is known as to their origin.

Hyaline Excrescences from Lamina Vitrea.—These consist of isolated pale or whitish round dots, slightly raised above the eye-ground, and usually bordered with

pigment. They do not coalesce and are found *peripherally*. Scattered among them are smaller black points. They usually occur in old people, and as vision is unaffected, they are only discovered by accident.

Hyaline Bodies in the Optic Disc ("Drusen").—The cause of this rare affection is not known. It may appear in healthy eyes or, as is often the case, is associated with retinitis pigmentosa, neuroretinitis, and in-

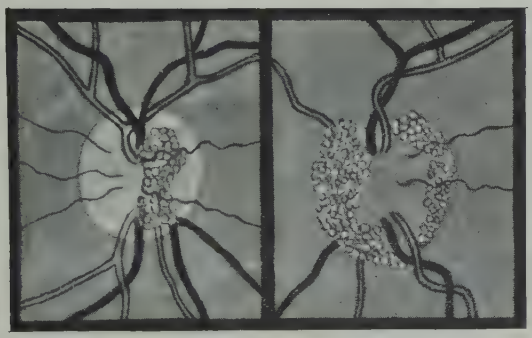

FIG. 55. FIG. 56.

FIGS. 55, 56.—HYALINE BODIES IN THE OPTIC DISC.—(*Nieden.*)

juries to the eye. The bodies consist of a rather hard hyaline substance, but according to late researches they have no connection with colloid excrescences of the lamina vitrea of the choroid. With the ophthalmoscope they appear as small sago-like bodies 2 to 3 millimeters in diameter, somewhat translucent or of a yellowish-white color, and often give back a brilliant reflection. They are usually found in groups at the periphery of the disc, but in some cases completely cover the disc and

may extend some distance onto the retina (Figs. 55, 56). When the bodies are few in number, they may be easily overlooked. In uncomplicated cases vision is normal. The condition usually remains stationary and no treatment is required.

CHAPTER VI.

DISEASES OF THE CHOROID.

Hyperemia of the choroid is necessarily present in many diseased conditions; but as the choroidal vessels are usually invisible, no positive diagnosis is possible.

Etiology.—Hyperemia may be caused by inflammation of the iris and ciliary body, injury, sympathetic ophthalmia, eye-strain, myopia, or exposure to bright light and heat.

Subjective Symptoms.—Aching of the eyes, intolerance of artificial light, and other asthenopic symptoms.

Ophthalmoscopic Appearances.—The only evidence of hyperemia of the choroid is a reddish discoloration of the disc, striation of the retina in its vicinity, faint dark areas in the periphery indicating the interspaces between the choroidal vessels, and a vivid "flannel-red" tinge of the choroid. According to Loring, in hyperemia of the choroid the connective-tissue ring is well defined, especially to the temporal side of the disc, while in retinal disease it is obscured.

Diagnosis.—This should be made with caution.

Treatment.—Dark glasses, atropin, and proper correction of the refractive error.

Choroiditis.

On account of its extreme vascularity and sluggish circulation, the choroid is peculiarly liable to inflamma-

tion. The general term *choroiditis* is used to include inflammation in actual progress and the degenerative changes which remain after the inflammation has run its course. Choroiditis may be divided into purulent choroiditis and exudative choroiditis.

Purulent Choroiditis.—This consists of a violent inflammation of the choroid in which a purulent exudate is formed beneath the retina and invades the vitreous. In most cases it extends to the ciliary body and iris, leading to destruction of sight and atrophy of the globe.

Etiology.—The disease is caused by septic infection after perforating wounds, foreign bodies, septic cataract extraction, and purulent keratitis; or it may develop as *metastatic choroiditis* from septic embolism in puerperal fever, pyemia, and endocarditis. A milder type is seen in children with cerebrospinal meningitis.

Pathology.—The choroid and retina are thickened from an infiltration of pus cells, the retina may be partially or entirely detached, and the vitreous becomes a mass of pus.

Subjective Symptoms.—There is intense pain in the eye and brow, which in violent cases may be almost intolerable. The globe is tender and vision is lost. Constitutional symptoms, fever, chill, and vomiting may be very marked.

Objective Symptoms.—If the process is confined to the choroid, retina, and vitreous, the disease runs a chronic course, with no visible signs except a yellowish mass seen in the vitreous by transmitted light and sometimes mistaken for glioma of the retina; but as a rule the inflammation spreads to the entire uveal tract, causing

edema of the lids, chemosis and injection of the conjunctiva, haziness of the cornea, hypopyon and inflammation of the iris and ciliary body. The pupil is dilated, the anterior chamber shallow, and the tension increased. In some cases the inflammation subsides in a few weeks and the eyeball becomes softer, smaller, and gradually passes into a state of atrophy.

In *violent* cases all the tissues of the eyeball become involved in the suppurative process (panophthalmitis) and the globe is pushed forward by inflammatory infiltration of Tenon's capsule. Finally, in the course of six or eight weeks, the purulent exudate breaks through the sclera or cornea and the eye is at last free from pain, becomes softer, shrunken, and sightless (phthisis bulbi).

Diagnosis.—In children the disease may be mistaken for glioma, and hence is sometimes called pseudo-glioma. It is to be distinguished from glioma by the evidences of a previous inflammation—*i. e.*, vitreous opacities, posterior synechiæ, and retraction of the iris at its periphery.

Prognosis.—This is unfavorable, as the disease usually ends in blindness and phthisis bulbi. When due to pyemia or meningitis, the life of the patient is also in danger.

Treatment.—Pain is to be relieved by hot compresses of bichlorid solution, and atropin; internally, opium and quinin in full doses. As soon as the suppuration becomes general, the pus may be evacuated by a free incision into the sclerotic. This relieves pain and cuts short the progress of the disease.

Exudative or Plastic Choroiditis.—This is a chronic, non-suppurative inflammation of the choroid with fibrino-

plastic exudation. There is always exudation into the retina and frequently into the vitreous. Exudative choroiditis is the most common form of inflammation of the choroid, and is usually meant when the term choroiditis is used.

Etiology.—Inflammation of the choroid is a frequent disease, may be congenital or acquired, and is very apt to affect both eyes. It may be caused by some disorder of the general system, as syphilis, disease of the kidney, anemia, chlorosis, and scrofula, or it may result from injury, hemorrhage, myopia, and old age. In many cases the cause is obscure.

Subjective Symptoms.—Choroiditis develops and runs its course without severe pain or external congestion. In the early stages there may be subjective sensations of light (photopsia) and distortion of images (metamorphopsia), the former owing to irritation and the latter to a pushing forward of the retina. In the later stages vision is diminished or lost at the seat of each atrophic patch. These gaps in the field of vision (scotomata) may not be noticed by the patient if peripherally situated, but if the macula region is involved, direct vision is destroyed. Good vision is sometimes retained even when the choroiditis is quite extensive. Vision may also be diminished as a whole as a result of secondary opacities in the lens and vitreous.

Ophthalmoscopic Appearances.—1. Stage of Exudation: The disease commences as small circumscribed areas of cellular exudation in the superficial layers of the choroid, which are not visible until the retinal pigment is destroyed. They appear as pale, pinkish-yellow spots

of a more or less circular form scattered over the fundus (Fig. 57). The spots are slightly raised, have soft-looking edges, and may be distinguished from retinal disease by the fact that the retinal vessels pass over them. The spots tend to occur in patches and are surrounded by healthy choroidal tissue. At this stage the exudation may become absorbed, leaving the choroid in

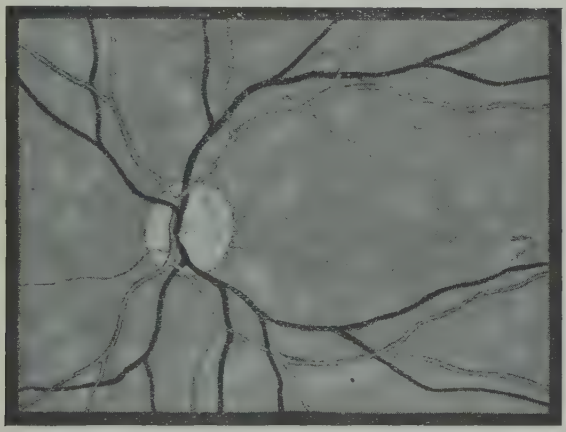

FIG. 57.—CHOROIDITIS; STAGE OF EXUDATION.

a comparatively healthy state; but more frequently the spots increase in size, run together, and pass on to the stage of atrophy. In some cases of acute choroido-retinitis due to syphilis the first symptom may be edema of the retina, which appears as a soft, white-looking area shading off into the adjacent fundus. When this clears up in the course of a few weeks, a patch of partial or complete atrophy is exposed to view.

2. Stage of Atrophy: Here the affected area of the choroid becomes destroyed, leaving white patches of bare sclerotic, surrounded or dotted over more or less with deposits of pigment from the choroid and retina (Fig. 58). In some cases the deposit of pigment is excessive, and instead of white areas there may be spots of pigment surrounded by a pale or yellowish margin. Often the

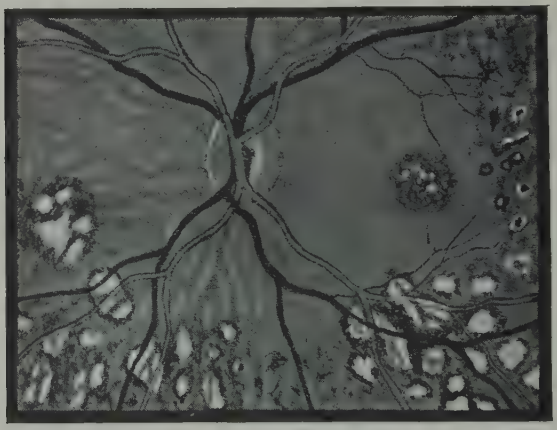

FIG. 58.—DISSEMINATED CHOROIDITIS; ATROPHIC STAGE.

retinal pigment over the whole fundus becomes atrophied, exposing to view the choroidal vessels. Sometimes an atrophic spot increases in size without evidence of fresh exudation, simply from the fact that the nutrition of the adjacent tissue is interfered with. The disease may subside and again advance at a later period, and the formation of a fresh patch is indicated by edema of the retina. Sometimes a white patch is crossed by one or more

choroidal vessels, which shows that the atrophy is not complete.

Changes in the Retina and Disc in Choroiditis.—1. Deposits of Pigment: The changes in the retina noted in the early stage of the disease may advance, leading to destruction of its nervous elements and to deposits of pigment in the anterior layers of the retina, simulating

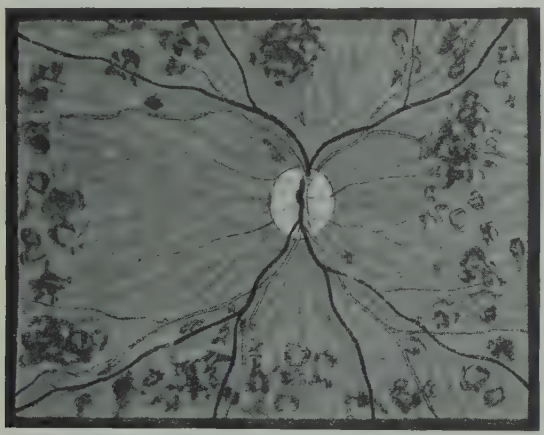

FIG. 59.—CHOROIDAL DEGENERATION.
The deposits of pigment resemble closely those found in retinitis pigmentosa. The nerve is atrophic.

retinitis pigmentosa (Fig. 59). In such cases the disc appears of a dirty white color and the retinal vessels are narrowed.

2. Cicatricial Bands in the Retina: Cicatricial bands of connective tissue may form in the retina and appear as a large, irregular, glistening white patch with processes extending in different directions and numerous oval

openings with sharply cut edges, through which the red fundus is seen at a deeper level (Fig. 60). It is differentiated from "retinitis proliferans" by the fact that the retinal vessels cross over the patch.

Changes in the Vitreous in Choroiditis.—Opacities in the vitreous are usually present and are due to an extension of the inflammation to the ciliary region. In

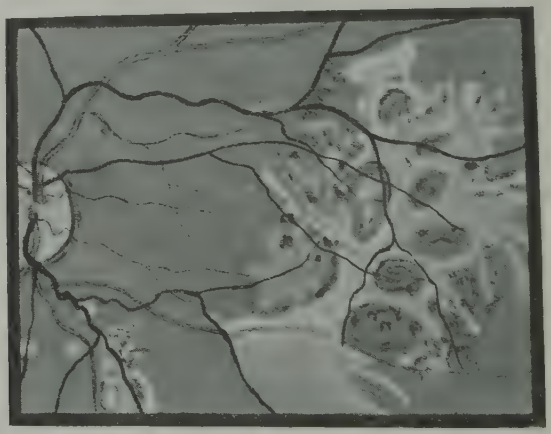

FIG. 60.—CICATRICIAL BANDS IN THE RETINA.—(*Frost.*)

the early stages of choroiditis, especially when due to syphilis, fine dust-like opacities, which are either fixed or but slightly movable, are found usually in the anterior part of the vitreous. Such opacities blur the details of the fundus so that the condition is often mistaken for optic neuritis. In severe cases the vitreous opacities may be so numerous that no details of the fundus are visible; when these clear up, patches of choroidal

atrophy may be discovered. Fine dust-like opacities are easily overlooked unless a careful search is made. They are best seen by feeble illumination and with a plane mirror with a +8.00 D lens behind the sight-hole. In the more advanced stages of choroiditis the vitreous opacities are larger, and form dark threads or masses which usually move freely in the vitreous. In hereditary syphilis the choroiditis may be found when the cornea clears up after interstitial keratitis.

Changes in the Lens and Iris in Choroiditis.—The extension of the inflammation to the ciliary region impairs the nutrition of the lens and leads to opacities, which usually begin at the posterior pole and remain stationary for a long time, or in some cases involve the whole lens. Inflammation of the iris sometimes occurs, leading to posterior synechiæ and deposits of lymph on the posterior surface of the cornea (keratitis punctata).

Diagnosis of Choroiditis.—This is usually easy. The disease may be overlooked if the patches are confined to the outlying portions of the fundus. It is important to distinguish between choroiditis in actual progress and choroiditis which has come to a standstill. In *recent choroiditis* the spots are pale, pinkish-yellow, with soft-looking edges and free from pigment. In *old* choroiditis the spots are white and surrounded or dotted over more or less with deposits of pigment. In *partial atrophy* of the choroid the larger choroidal vessels are peculiarly distinct on the white patch; in *complete* atrophy the vessels are less marked and few in number. In most cases choroiditis is complicated with secondary retinitis, and it is often difficult to decide whether small masses of

pigment lie in the choroid or retina. If a retinal vessel crosses in front of the pigment mass, it must be situated in the choroid; but if the spot of pigment covers the vessel, the pigment must lie in the retina.

Course and Progress.—Choroiditis is a very chronic disease, extending over many months or even years. There is a great tendency to recur, new foci of inflammation developing until the choroid is ultimately covered with atrophic spots. In obstinate cases the retina and optic nerve become atrophic, and the lens opaque. The disease, however, usually comes to a standstill before sight is totally lost. The prognosis is always grave, especially when the disease encroaches upon the macula region. The most favorable cases are those due to syphilis.

Treatment.—During the active stages of the disease dark glasses should be worn, and no reading or close work allowed. Internal treatment consists in combating the cause of the disease. Even in non-syphilitic cases a course of mercury and iodid should be given to hasten the absorption of the exudate.

Varieties of Choroiditis.—Exudative choroiditis may invade any part of the choroid, and from its position and cause may be divided into: (1) Disseminated ohoroiditis; (2) syphilitic choroido-retinitis; (3) central choroiditis; (4) posterior sclero-choroiditis or myotic choroiditis.

Disseminated Choroiditis.—*Etiology.*—The most frequent cause is acquired syphilis, and the disease appears from six months to two years or more after infection; in congenital syphilis it appears shortly after birth and later is often associated with interstitial keratitis.

Other causes are tuberculosis, rheumatism, injury, bad conditions of nutrition, and, according to Hutchinson, it is occasionally observed as a family disease associated with disorders of the nervous system. In many cases the cause is obscure. The disease usually affects both eyes, though one may be much more extensively implicated than the other.

Subjective Symptoms.—Central vision is usually lowered and the patient complains of black specks, or a mist before the eyes. If the disease is confined to the periphery, central vision may not be affected, and the condition may be revealed only as the result of a routine ophthalmoscopic examination. In some cases central vision is normal, even though fine dust-like opacities are seen in the vitreous.

Ophthalmoscopic Appearances.—In the *early stages* of the disease, usually not coming under observation, small pinkish-yellow spots with softened edges are seen scattered over the periphery of the fundus, and later encroaching upon the posterior pole of the eye (Fig. 57). As the disease advances the choroidal tissue is destroyed, and from exposure of the sclerotic the spots appear white, with a border or ring of pigment. The spots increase in size, coalesce to form patches, and have a punched-out appearance (Fig. 58). Instead of white spots, masses of pigment surrounded by a pale or yellowish ring may be the most conspicuous feature of the disease.

Vitreous Opacities: Fine dust-like opacities or string-like membranes are often found floating in the vitreous.

The Disc: In the later stages of the disease the optic

disc first becomes hazy and afterward atrophic (choroidal atrophy), and the *retinal vessels* contracted.

Diagnosis.—This is readily made from the ophthalmoscopic appearances. In attempting to make a diagnosis as to the probable cause of the disease, dust-like opacities in the vitreous point very strongly to a syphilitic origin, but it is not safe to come to any definite conclusion until a study is made of the history and systemic condition.

Prognosis.—The disease runs a chronic course and the prognosis is always grave; it is best in the syphilitic cases and in those in which the disease is confined to the periphery.

Treatment.—In the early stages all close work must be forbidden, and to this end atropin may be used and the eyes protected with dark glasses. Tonics are indicated to build up the general health. Whether there is a history of syphilis or not, a prolonged course of bichlorid of mercury, iodids, and tincture of iron is advisable. In tubercular cases, cod-liver oil, hypophosphites, and creosote may be used. In rheumatic cases, salicylate of sodium, arsenic, or colchicum should be employed.

Syphilitic Choroido-retinitis.—*Etiology.*—This, as its name implies, is due to inherited or acquired syphilis, and comes on from six months to three years after infection. Both eyes are usually affected.

Subjective Symptoms.—Central vision is usually much lowered, from the presence of fine dust-like opacities in the vitreous. When testing the sight, vision often improves, as the vitreous opacities sink to a lower level. Night-blindness is often present.

Ophthalmoscopic Appearances.—The ophthalmoscope reveals extensive pale-colored areas, most numerous toward the periphery and separated by healthy fundus. The patches have a superficial look resembling edema of the retina (Fig. 61). There is little or no pigment-heaping, and from the fact that the areas resemble islands, continents, etc., or take the shape of oak leaves, they are sometimes described as "map-like" or "leaf-like." The

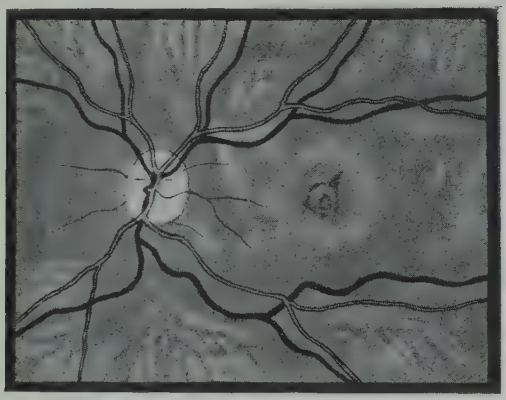

FIG. 61.—SYPHILITIC CHOROIDO-RETINITIS.

disease runs a very chronic course and shows but little change with the lapse of time.

Vitreous Opacities: Fine dust-like opacities in the vitreous may be the first symptom of the disease, and persist for months. In time they may clear away to some extent and be replaced by larger and blacker opacities.

The Disc: The disc is at first reddish-yellow, with

blurred edges, and later becomes white as a result of atrophy.

The Retinal Vessels: The veins are often swollen and arteries narrowed.

Late Stage of the Disease (Atrophy of the Choroid): In course of time, especially in old people, the retinal

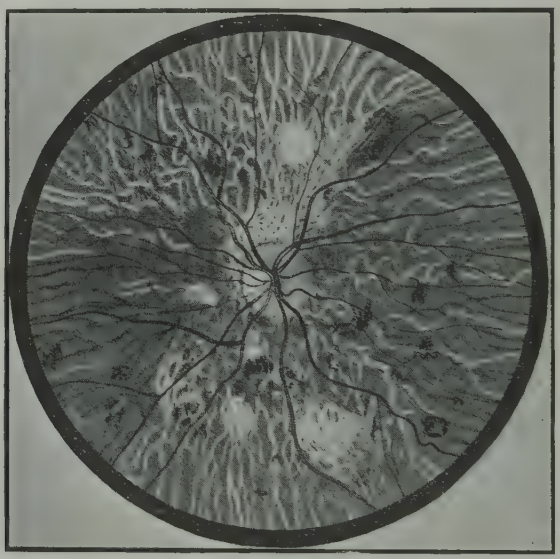

FIG. 62.—ATROPHY OF THE CHOROID.—(*Frost.*)

pigment disappears, and the fundus is of a reddish-brown color, exposing the choroidal vessels; those in the neighborhood of the disc often appear as white flat lines. Masses of pigment are found scattered over the fundus, often lying in the retina and concealing the retinal vessels (Fig. 62). This condition differs from the physio-

logic "tiger-skin" fundus in that the choroidal vessels are thickened and often white, and the pigment is scattered in fragments over the retina. The disease might be mistaken for retinitis pigmentosa, but in the latter the choroidal vessels are not usually exposed and the pigment has the characteristic delicate lace-like pattern.

Diagnosis.—The diagnosis of syphilitic choroido-retinitis may be difficult if the disease is not well marked, and the patches are situated far forward, or when the details of the fundus are obscured by dense masses of dust-like opacity in the vitreous.

Prognosis.—The disease runs a very chronic course, but under early and vigorous treatment surprisingly good results may be obtained.

Treatment.—Inunctions of mercurial ointment are the best treatment. One or two drams of the ointment are to be rubbed into the skin of the axillæ or inner side of the thighs each night. After a time, if there is any sponginess of the gums, the inunctions should be replaced by a course of iodid of potash.

Central Choroiditis.—Here the disease is confined to the region of the macula and is often symmetrical.

Etiology. — Central choroiditis may be caused by syphilis, blows on the eye, hemorrhage, myopia, and uncorrected ametropia, or as the result of a senile change.

Subjective Symptoms.—Central vision is usually much reduced, and testing will show a more or less extensive scotoma.

Ophthalmoscopic Appearances.—(*a*) Senile Choroiditis (Fig. 63): Here the macula may be occupied by a cir-

cular or oval, sharply defined white patch about the size of the disc (often much larger), the rest of the fundus being normal. The choroiditis may be superficial and appear as a more or less extensive patch of exposed choroidal vessels, with thickened walls, and deposits of pigment. In other cases the patches may resemble those of disseminated choroiditis, with minute hemorrhages and crystals of cholesterin. Sometimes a zone

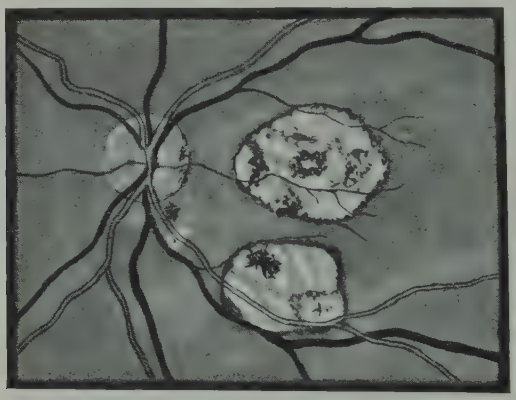

FIG. 63.—CENTRAL CHOROIDITIS.

of choroid immediately around the disc may become atrophic (Fig. 64).

(*b*) Senile Guttate Choroiditis, first described by Tay and Hutchinson, consists of groups of fine yellowish-white dots situated in the macula region, or between it and the disc ; occasionally they follow the course of the larger blood-vessels. There is little or no pigment disturbance. The dots may be easily overlooked and are

often only seen by the direct method. The disease is due to colloid degeneration in the anterior layers of the choroid and invades the retina. It may produce a partial central scotoma, though in many cases vision does not seem to be affected. The disease is symmetric and remains stationary.

Treatment is of no avail.

(*c*) Anomalous Forms: Occasionally the macula is the

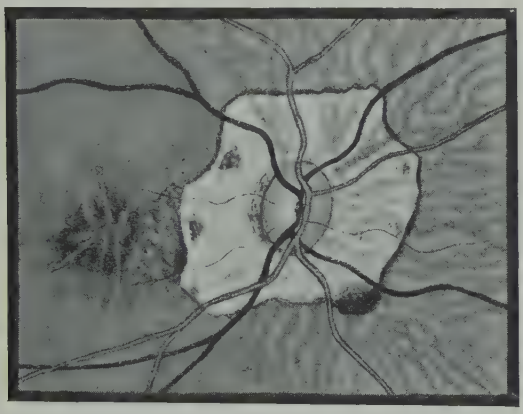

FIG. 64.—SENILE CHOROIDITIS.

seat of a more or less extensive area of almost complete atrophy of the choroid. The patch is oval or circular, often several times the size of the disc, and has a sharply defined edge, often covered with black masses of pigment (Fig. 53). The sclerotic within the affected area bulges backward and forms a "crater," and the choroidal vessels are freely exposed, or in some cases entirely destroyed. The changes are stationary and most probably

present at birth. This condition is not a coloboma of the choroid, though it resembles it in many respects.

Prognosis.—Central vision is apt to be greatly diminished or lost.

Treatment.—This is the same as for disseminated choroiditis (p. 98).

Choroiditis with Descemetitis. — Occasionally in young adults, especially females, with a family history

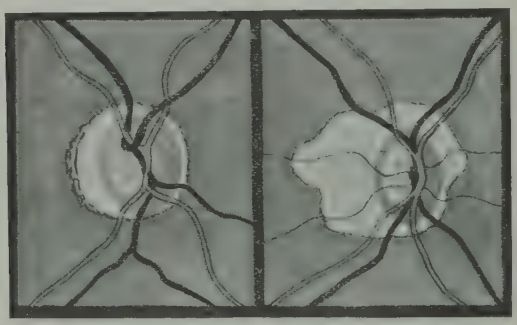

FIG. 65. FIG. 66.

Fig. 65, Posterior staphyloma in myopia of moderate degree and apt to remain stationary. Fig. 66, Posterior staphyloma in myopia of high degree (progressive myopia).

of tuberculosis, solitary patches of choroido-retinitis are found associated with dust-like opacities in the vitreous and a deposit of fine gray dots on Descemet's membrane. Under antitubercular treatment the dots on the back of the cornea fade away, the vitreous clears, and normal vision may be regained.

Myopic Choroiditis. — (*a*) *Posterior Staphyloma.*— This consists of a white crescent at the temporal side of

the disc, due to stretching and atrophy of the choroid at that point, with bulging backward of the sclerotic (Figs. 65, 66). The crescent is not always of a uniform color, being bluish-white next to the temporal side of the disc, where the atrophy is most complete, and of a less pronounced white as the degree of atrophy diminishes. The crescent may be bounded by a more or less well-marked line of black pigment. When the myopia is of a low de-

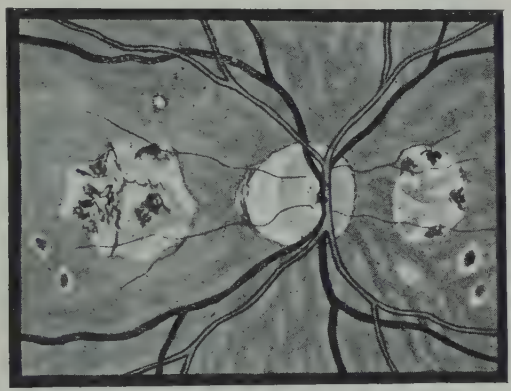

FIG. 67.—MYOPIC DEGENERATION OF THE CHOROID—PROGRESSIVE MYOPIA.

gree and stationary, the crescent is small and has a clear-cut, regular outline. In high or progressive myopia the crescent has an ill-defined and irregular boundary, and may completely encircle the disc and extend a long way in the direction of the macula. In some cases the vessels on the disc are displaced. In rare cases a "myopic crescent" is seen in emmetropic and hyperopic eyes, and is commonly found as a senile change.

(*b*) *Myopic Degeneration of the Choroid.*—(Fig. 67.) In bad cases of progressive myopia the choroid is apt to be greatly thinned, and with the extension of the myopic crescent, spots of choroidal hemorrhage or pigment and small cracks or fissures may appear in the macula region which in time result in patches of choroidal atrophy. Central vision is usually much impaired.

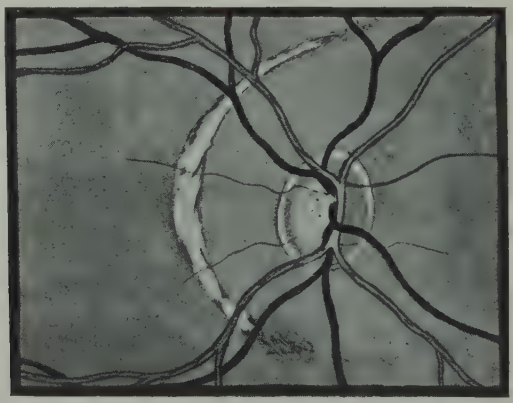

FIG. 68.—RUPTURE OF THE CHOROID.—(*After Jackson.*)

Prognosis.—Myopic choroiditis is apt to progress and vision become greatly reduced.

Treatment.—Absolute rest for the eyes, atropin and dark glasses; also tonics and out-door exercise. Later glasses accurately correcting the refractive error should be worn, and close work avoided as much as possible.

Rupture of the Choroid.—This condition occasionally follows a blow upon the eye. The rupture may be

in any part of the fundus, but is usually situated a short distance from the disc on the temporal side. After the hemorrhage into the vitreous, which follows the blow, has disappeared, the ophthalmoscope shows one or more yellowish-white crescents bordered with pigment and with the concavity toward the disc (Fig. 68). If the retina is not torn, the retinal vessels pass over the rupture. At first, vision is much impaired from hemorrhage, but if the rupture is some distance from the macula region, normal vision may be regained.

Treatment.—This consists in the use of atropin, a pressure bandage, and rest in bed.

Detachment of the Choroid.—This condition is exceedingly rare. It appears as a smooth globular mass of a yellowish color, projecting into the vitreous body, and crossed by the retinal vessels. According to Meyer, it is distinguished from detachment of the retina by the fact that it does not change its position with the movements of the eyeball. The diagnosis would be difficult if there was also a detachment of the retina.

Hemorrhage in the Choroid.—Occasionally in high myopia or after a blow upon the eye, a large diffuse patch of hemorrhage is seen in the choroid. It differs from retinal hemorrhage in that it is not flame-shaped and the retinal vessels cross over it. After absorption a patch of atrophy marks its site.

Colloid Disease of the Choroid.—Occasionally in young adults, but more frequently as a senile change, the posterior pole of the eye, especially the macula region, is studded over with round, grayish-white or transparent bodies or spots about the diameter of the retinal

vessels. They may be discrete or coalesce at the macula to form a mulberry-like mass which projects from the inner layer of the lamina vitrea (Fig. 69). A trace of pigment may be present, usually at the margins, so that the spots may closely resemble disseminated choroiditis. The change is symmetric and vision remains normal.

Tubercle of the Choroid.—This is one of the symptoms of acute general miliary tuberculosis. The tuber-

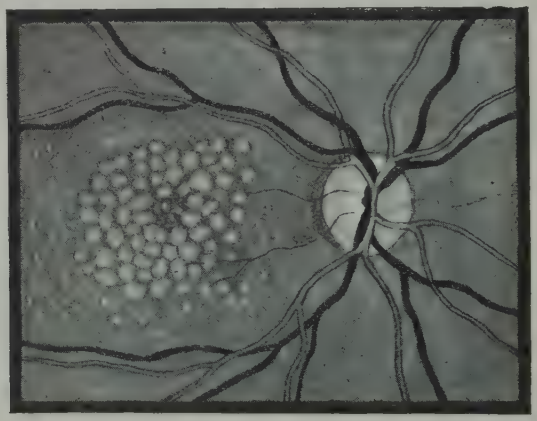

FIG. 69.—COLLOID DISEASE OF THE CHOROID.

cles appear as small, round, slightly elevated, pale yellowish nodules, varying in size from 0.3 to 2.5 millimeters. They are sometimes quite numerous, and are always found in the vicinity of the disc. Tubercles may be distinguished from ordinary choroiditis in that they are unaccompanied by pigmentary changes. They usually occur late in the disease, but in obscure cases the fundus change may throw light upon the diagnosis. In

rare cases a solitary tubercle is observed, which grows to a large size and finally destroys the eye. It occurs with cerebral tubercle.

Sarcoma of the Choroid.—This is the most common malignant growth of the eyeball and is usually pigmented (melanosarcoma), more rarely without pigment (leukosarcoma). The growth may be round or spindle-celled, and develops from the external layers of the choroid and grows inward, pushing the retina before it.

Symptoms.—Four stages of the disease are recognized.

First Stage: If seen at this time, which rarely happens, a small brownish mass or tumor is observed with a lifting-up or detachment of the retina at the site of the growth. There is a corresponding defect of vision, which may escape attention unless the tumor is situated in the macula region. Statistics show that the duration of this state is from one and a half to two years.

Second Stage: Owing to the increasing size of the growth, the *tension* is increased and the eye presents the symptoms of inflammatory glaucoma. There is pain, injection of the eyeball, haziness, and anesthesia of the cornea. The anterior chamber is shallow, the pupil dilated and immobile, the iris is discolored, the lens opaque, and the retina totally detached. If seen before the media become cloudy, the fact of increased tension with detachment of the retina should awaken suspicion of an intraocular growth.

Third Stage: The sclera ruptures either anteriorly, when the growth appears as a dark, hard mass, or posteriorly, when the only evidence is a gradually increasing protrusion of the eyeball (exophthalmus). The tumor

now grows rapidly, fills the orbit, and may pass backward into the brain.

Fourth Stage: This consists in the development of metastatic nodules in the internal organs, most frequently in the liver. In some cases metastasis occurs before rupture of the sclera.

Diagnosis.—This is often difficult. It is to be distinguished from *simple detachment* of the *retina* by the presence of increased tension and dilation of the ciliary veins on one side; from *glaucoma* by the fact that miotics are useless and there is no remission in the symptoms; from *glioma* of the retina by the fact that sarcoma is rare, except in adult life, while glioma is a disease of childhood.

Prognosis.—The disease is very malignant, and death occurs within five years unless the eye is removed in the early stages. Recurrences are frequent, and the patient should not be considered out of danger until at least four years have elapsed with no return of the disease.

Treatment.—The eye should be enucleated at once, cutting off the optic nerve as far back as possible. After the growth has broken through the sclera, the entire contents of the orbit, including the periosteum, should be removed.

CHAPTER VII.

DISEASES OF THE RETINA.

Anemia and Ischemia of the Retina.—*Anemia* is merely a symptom of local pressure or of general disease. Ischemia is an intense form of anemia.

Etiology.—Anemia may develop *suddenly*, as a result of occlusion of the vessels, as in embolism of the central artery, or through their compression from sudden increase of tension. It is seen in the collapse stage of cholera, in whooping-cough, and under the influence of toxic doses of quinin. More commonly anemia of the retina develops *gradually*, as a consequence of retinal atrophy.

Subjective Symptoms.—There is partial or complete loss of sight, which is usually only temporary, but in severe cases some defect of central vision, with contraction of the field, is apt to remain.

Ophthalmoscopic Appearances.—In marked cases the fundus is of a light color, the optic disc pale, and the retinal vessels narrowed. When the anemia is the result of retinal atrophy, the vessels are bounded by white lines, the result of a thickening of the vessel walls, or may appear as fine white threads empty of blood. In some cases they disappear altogether from the retina.

Treatment.—The use of digitalis, strychnia, nitrite of amyl, and tonics.

Hyperemia of the Retina.—*Etiology.*—Hyperemia may be caused by inflammation of the cornea, iris, ciliary body, etc., and is often seen in ametropic eyes, the result of eye-strain.

Subjective Symptoms.—Vision is generally but little disturbed. The patient may complain of sensitiveness to light and other asthenopic symptoms.

Ophthalmoscopic Appearances. — 1. The Retina: Changes in the retina are often slight and confined to the region immediately around the disc. The increased redness may present a diffuse tinge due to congestion of the network of capillaries and finer vessels situated in the deeper layers of the retina, or it may follow the striping of the nerve-fibers. The fundus may have an "angry look" or appear hazy and out of focus, and there are often slight changes in the choroidal pigment.

2. The Disc: Changes in the disc are more marked than in the retina. The disc is abnormally red, especially the nasal half, but the edges are well defined. The injection follows the course of the larger vessels and has a radiating appearance. In marked cases the edges of the disc are veiled or slightly obscured.

3. The Vessels: The larger retinal vessels may be enlarged and tortuous, especially the veins, but in most cases the changes are confined to the finer vessels and capillaries.

Diagnosis.—The diagnosis must be made with caution, and depends more on the enlargement of the retinal vessels than on an increase in the red of the fundus; at the same time it must be remembered that enlarged and tortuous vessels are frequently observed in perfectly

healthy eyes. Hyperemia of the retina must not be confounded with the haze produced by fine vitreous opacities.

Treatment.—Rest of the eyes, dark glasses, and the correction of the refractive error.

Retinitis or Inflammation of the Retina.—*Etiology.*—Retinitis occasionally appears as a local lesion from the action of intense light upon the eye. In most cases it is merely a symptom of some general disorder, as albuminuria, diabetes, leukemia, syphilis, and diseases of the vascular system. Often no cause can be discovered.

Pathology.—The changes observed in the retina as the result of inflammation are exudation, fatty degeneration and sclerosis of the nerve elements and supporting tissue, leading to the formation of white patches, thickening of the walls of the blood-vessels, and migration of the pigment cells.

Subjective Symptoms.—In the early stages central vision may be normal, but in most cases it is diminished in proportion to the severity and situation of the inflammation. The field of vision may be contracted or scotomata be found, corresponding to the retinal exudates.

Ophthalmoscopic Appearances.—1. Loss in the Transparency of the Retina: This is a most important symptom of retinitis. It varies from a faint haze, just visible by subdued light, to a diffuse cloudiness, usually most distinct in the vicinity of the disc, which conceals everything behind it. In many cases the cloudiness is circumscribed or follows the course of the larger vessels.

2. Exudation into the Retina: The exudation appears as soft-toned white spots, or irregular-shaped patches

scattered over the fundus, or localized about the disc and macula region. The patches are sharply defined, and when situated in the anterior part of the retina, hide the retinal vessels. Their situation, soft tone, and absence of choroidal pigment distinguish these patches from those due to atrophy of the choroid.

3. Changes in the Retinal Vessels: *The veins* are usually enlarged, darker than normal, and increased in length, as is shown by their greater tortuosity. *The arteries* may be normal or narrowed, but the finer transverse branches are often very tortuous. The capillaries become injected and form a fine, red striation. The retinal vessels may be partially concealed by the infiltrated tissue, or take an anterior posterior bend as they cross the swelling.

4. Hemorrhages in the Retina are frequent in retinitis, especially when due to some general disease. In some cases hemorrhages occur independently of retinitis. When the hemorrhages are situated in the nerve layer, they are flame-shaped, with well-defined lateral edges and feathery ends, and radiate from the disc. They are usually small, follow the course of the vessels, and sometimes partially conceal a small portion of one of them. The extravasation is apt to be from one of the larger vessels, though it is rare to find any visible rupture. When the hemorrhages are situated in the deeper layer, they are apt to be from the capillaries, and are more or less round, with clean-cut borders. A recent hemorrhage is of a bright red color; in time it becomes a dirty reddish-brown, gradually disappearing or leaving a spot of pigment or a white area bordered with pigment,

and showing more or less of the structure of the choroid.

5. Pigmentation of the Retina: Small spots of pigment may be due to inflammation or to former hemorrhages, but may occur independently of retinitis. In atrophic conditions of the retina the pigment has a "lace-like pattern," or resembles "bone corpuscles." It is sometimes difficult to decide whether the pigment is situated in the retina or choroid. If a retinal vessel is seen to cross in front of the mass of pigment, it is choroidal; while if the pigment covers the vessel, it lies in the retina.

6. Changes in the Disc: In retinitis the disc takes on a deeper tinge and its outlines become indistinct and obscure; it may show all the symptoms of neuritis and later go on to atrophy.

7. Opacities in the Vitreous often accompany severe forms of retinitis.

8. Atrophy of the Retina is the final outcome of many cases of retinitis. The vessels are extremely narrowed, and bounded by white lines. The retina may remain transparent or show yellowish-white spots of exudation. If the choroid is involved, a white patch of sclera is exposed. The pigment heapings have a lace-like pattern.

Diagnosis.—The type of retinitis will depend upon the grouping of the various symptoms, loss of transparency, exudation, hemorrhage, pigmentation, and atrophy; also the effect of the disease on the visual acuity and field of vision.

Prognosis.—In mild cases the inflammation may sub-

side in a few weeks, with a return to normal vision ; but in most cases the disease runs a slow course over a period of months, and leaves the sight permanently impaired. In severe cases the nerve and retina become atrophic and sight is almost entirely lost.

Treatment will depend upon the clinical variety of the disease. In general terms, the eye should be given complete rest, atropin should be instilled, and dark glasses worn. Internal treatment consists in the use of mercury, iodid and bromid of potassium, ergot, saline purgatives, and diaphoretics.

The various types of retinitis will now be described :

Serous Retinitis (Simple Retinitis, Edema of the Retina).

Etiology.—Simple retinitis may be due to syphilis, blows, sympathetic ophthalmia, cold, eye-strain, and exposure to undue light or heat.

Pathology.—There is hyperemia and edema, with infiltration of leukocytes, especially in the nerve-fiber and ganglionic layers of the retina.

Subjective Symptoms.—Central vision is diminished and the field contracted. The edema into the retina causes distortion of vision ; objects may appear larger than normal (megalopsia) or smaller (micropsia). In some cases the patient sees better at dusk (nyctalopia).

Ophthalmoscopic Appearances—1. Edema of the Retina : The retina is veiled by a soft grayish-white opacity, most marked around the disc (Fig. 70). The edema may involve the whole retina or be circumscribed.

2. The Disc is red and its margins obscured by the edematous infiltration.

3. The Retinal Vessels: The *arteries* may be normal or narrowed by compression. The *veins* are dark, distended, tortuous, and partially concealed by the swollen retina.

4. Hemorrhages rarely occur in this form of retinitis.

Diagnosis.—The delicate veiling of the fundus without exudation renders the diagnosis easy.

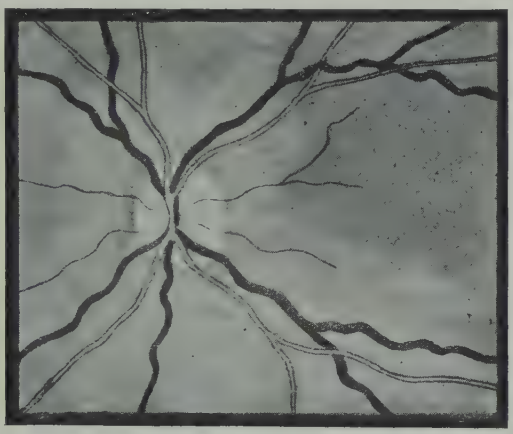

FIG. 70.—EDEMA OF THE RETINA.

Prognosis.—In mild cases, especially when due to syphilis, absorption may occur after appropriate treatment. A cautious prognosis, however, should be made, as the disease may assume a parenchymatous form.

Treatment consists in the use of a mydriatic, dark glasses, and the correction of any systemic disturbance.

Syphilitic Retinitis.—*Etiology.*—Inherited or acquired syphilis is a frequent cause of an inflammation

which may be confined to the retina (retinitis), but more frequently also involving the choroid (choroido-retinitis). In the acquired form of syphilis the retinitis appears in from six months to two years after infection, often only involving one eye.

Subjective Symptoms.—At first central vision may be but slightly affected, but in the later stages it is very defective, especially under weak illumination. Scotomata and irregular and concentric contraction of the visual field are found. Objects may appear smaller than normal (micropsia) or distorted (metamorphopsia); sparks or lights may seem to dance before the eyes.

Ophthalmoscopic Appearances.—1. The Retina: The entire retina is cloudy and faintly gray, or the opacity may surround the disc and stretch out in lines along the vessels (Fig. 61). Numerous yellowish or white spots of exudation are found in the periphery and macula region. These spots lie beneath the vessels of the retina, and in the later stages of the disease are bounded by pigment. Sometimes the only change noticed is a circumscribed patch of white exudate in the macula region or close to one of the larger retinal vessels. In time this is transformed into bluish-white scar-tissue, which in consequence of its shrinking may lead to detachment of the retina.

2. The Nerve: The disc is a dark red, and is seen indistinctly on account of the cloudy vitreous.

3. The Vessels: There is no material change in the vessels, except that the veins are darker than normal.

4. The Vitreous: Vitreous opacities in the shape of

fine dust-like particles are seen most numerously in the posterior portion of the vitreous.

Hereditary Syphilis.—The form of retinitis due to hereditary syphilis is seen usually after the disease has run its course. It consists of a single patch of exudate which has been transformed into connective tissue, or the fundus may be studded with small light or black spots.

Diagnosis of Syphilitic Retinitis.—A combination of the symptoms just described should at once awaken inquiry as to syphilitic infection.

Prognosis.—The disease runs a chronic course and is liable to relapses. A cure may be effected if suitable treatment is given at an early stage. If this is neglected, disseminated choroiditis, pigmentary degeneration of the retina, and atrophy of the optic nerve are apt to occur.

Treatment consists in the use of mercury, tonics, and iodid of potassium.

Albuminuric retinitis is a retinitis due to Bright's disease, in which, along with the general signs of retinitis, are white lines, dots, and patches arranged in a characteristic manner about the macula and disc.

Etiology.—This form of retinitis occurs in many cases of acute and chronic nephritis, especially the chronic granular type, and in the albuminuria of pregnancy. Both eyes are usually affected.

Pathology.—The disease consists of an alteration in the walls of the blood-vessels and inflammation and degeneration of the retina. The fine dots about the macula are the result of fatty degeneration of the inner ends of Müller's fibers.

Subjective Symptoms.—The only subjective symptom is impairment of vision, which may vary from slight dimness to complete blindness. In many cases an ophthalmoscopic examination leads to the discovery of kidney disease.

Ophthalmoscopic Appearances.—1. White Dots and Patches: The characteristic feature of this form of

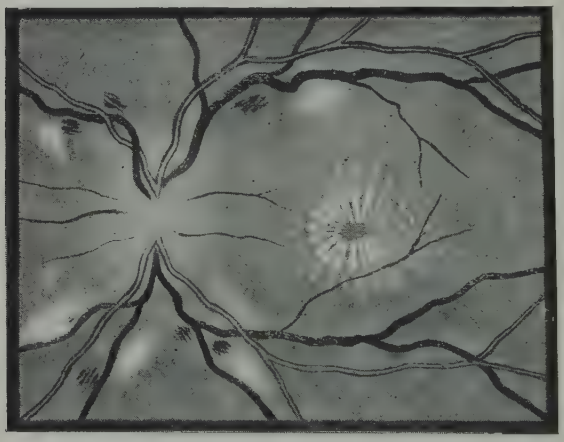

FIG. 71.—ALBUMINURIC RETINITIS.

retinitis is the presence about the macula and disc of well-defined lustrous white spots of various shapes and sizes. In the macula region they appear as fine white dots and lines arranged around the fovea in a star-shaped figure (Fig. 71). Sometimes this radiating figure does not completely encircle the fovea, but is found only on certain sides of it. Other and larger spots are seen in a certain area surrounding the papilla. These may coal-

esce and form a ring-shaped zone around the disc. The retina is hazy and shows fine injected lines radiating from the nerve-head.

2. Hemorrhages. Numerous flame-shaped or rounded hemorrhages are seen scattered here and there, usually in the neighborhood of the vessels. They may appear as mere flecks of blood or large extravasations, according to the intensity of the disease. Often old hemorrhages in the shape of pigment spots or white patches may be seen along with fresh extravasations.

3. The Retinal Vessels. The *veins* are dark, distended, and often tortuous. The *arteries* may be normal or enlarged. The vessels may be partially buried in the swollen retina and are seen to cross the white patches which lie in the outer layers of the retina and are concealed by those patches which lie in the nerve-fiber layer. In the later stages the vessels may be narrowed and bordered by white tissue or be converted into white cords.

4. The Optic Disc is hyperemic and clouded, or it may be swollen to such an extent as to resemble the papillitis seen in brain tumor.

Atypical Forms of Albuminuric Retinitis: Bright's disease may set up a retinitis which does not present the characteristic features just described. In some cases hemorrhages may be the most conspicuous feature of the disease; in others it is the swelling of the papilla. In some instances the only changes noticed are a few fine dots in the macula and one or more small hemorrhages. Hence, careful repeated examinations of the urine should be made in every case of retinitis.

Albuminuric retinitis of *pregnancy* differs somewhat from that due to chronic kidney disease. It consists of scattered hemorrhages, large white areas of retinal effusion, and considerable blurring of the disc (Fig. 72). Vision is greatly impaired at the time, but complete recovery may take place if the pregnancy terminates before the retina undergoes degeneration.

Diagnosis.—In a typical case of albuminuric retinitis

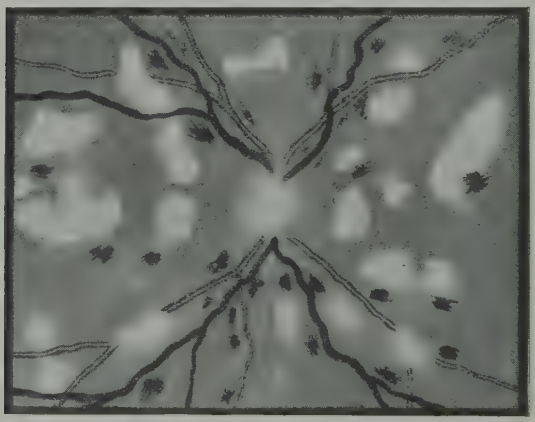

FIG. 72.—ALBUMINURIC RETINITIS OF PREGNANCY.

the ophthalmoscopic picture is characteristic and the diagnosis easy. Somewhat similar changes are found in glycosuria, leukocythemia, and neuroretinitis from brain tumor, so that a positive diagnosis will depend upon an examination of the urine and a study of the general symptoms.

Prognosis.—The white spots in the macula region usually remain permanently, although every other trace

of the disease may have disappeared. Vision is usually permanently impaired on account of the hemorrhages and the degenerative changes in the macula. As albuminuric retinitis usually occurs at a late stage of the kidney disease, the prognosis as regards life is grave ; a large majority of the patients die within two years of the discovery of the retinal changes.

Treatment.—Rest for the eyes, dark glasses, and remedies suited to the form of kidney disease present.

Diabetic Retinitis.—This is a form of retinitis which develops in the later stages of diabetes, but is a much rarer affection than albuminuric retinitis. It is always bilateral, and according to Hirschberg may be divided into an exudative and a hemorrhagic form.

Subjective Symptoms.—Central vision is diminished often out of proportion to the ophthalmoscopic appearances. The visual field may or may not be contracted. A central scotoma is often present, but according to Manthner it is not due to the diabetic process, but is the result of the abuse of tobacco and alcohol.

Ophthalmoscopic Appearances.—These are similar to those of albuminuric retinitis, though there are usually more hemorrhages and the white patches are larger, of softer tone, more scattered, and less frequently presenting the stellate arrangement seen in albuminuric retinitis (Fig. 73). Between the patches numerous points of extravasation are found, but in other respects the retina is transparent and healthy.

The *disc* and *blood-vessels* are often normal. *Opacities* and *hemorrhages* in the *vitreous* are much more common than in the retinitis of albuminuria. The disease is

sometimes complicated by high myopia, cataract, and glaucoma.

Diagnosis.—In many cases it may be difficult to distinguish it from *albuminuric retinitis.* The important points to remember are that in diabetes the disc and vessels are normal or but little affected and the retina is free from dimness and swelling. In *specific choroido-retinitis* there is always more or less disturbance of the pigment

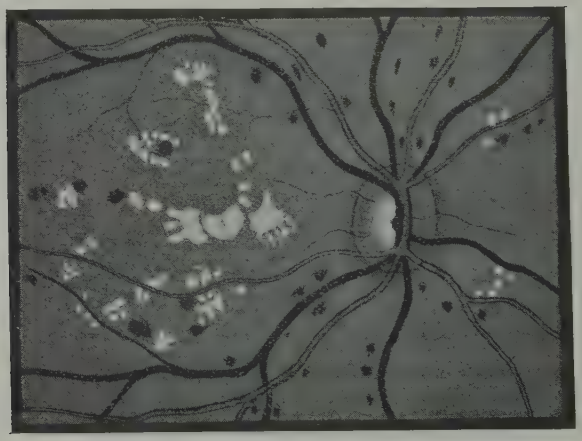

FIG. 73.—DIABETIC RETINITIS.

epithelium. In *retinitis punctata albicans* the spots lie behind the blood-vessels. In many cases, especially of hemorrhagic retinitis, the presence of sugar in the urine alone is the deciding symptom in the diagnosis.

Prognosis.—Diabetic retinitis is a very chronic affection which usually becomes worse in course of time. As it occurs late in the general disease, treatment is of little avail.

Treatment.—Rest for the eyes, dark glasses, and appropriate remedies for the general disease.

Leukemic Retinitis.—Like the primary affection, this form of retinitis is a rare disease. It affects both eyes and usually comes on as a late symptom of the general disorder.

Subjective Symptoms.—Vision is more or less affected,

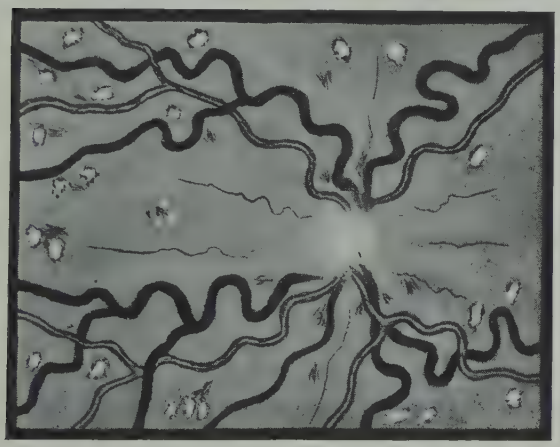

FIG. 74.—LEUKEMIC RETINITIS.

according to the location of the lesions. Blindness may result from hemorrhage into the vitreous.

Ophthalmoscopic Appearances.—1. The Retina: The fundus appears of an orange yellow color. There is a slight diffuse retinitis, most marked about the disc, associated with numerous minute hemorrhages, shaped like flames, stripes, and points. In some cases small, round, white elevated spots, with red borders of various widths,

are found in the macula region and toward the periphery (Fig. 74). The spots are due to a collection of lymph corpuscles, and the red border to extravasation of blood.

2. The Disc: The papilla is either pale, with indistinct margins, or greatly swollen, as in marked papillitis.

3. The Retinal Vessels: The most conspicuous change is in the retinal vessels. The *veins* are tortuous and enormously distended. The *arteries*, which resemble the veins closely in color, are also somewhat dilated.

Diagnosis.—In place of the characteristic appearance just described, leukemic retinitis may consist of a diffuse opacity of the retina or appear in the form of hemorrhagic retinitis. In such cases an examination of the blood and a study of the general condition will help to secure a proper diagnosis.

Prognosis.—The prognosis is bad, for as yet no cure has been reported. According to Mosler, there is some hope of a cure if the patient receives treatment at an early stage of the disease.

Treatment.—Dark glasses, strict diet, and the use of arsenic and quinin.

Hemorrhagic Retinitis.—This consists of an inflammation of the retina, with hemorrhages as the most prominent feature.

Etiology.—This form of retinitis occurs with disease of the heart and of the retinal vessels. Many of these cases are probably identical with those of thrombosis of the central vein (Fuchs). Hemorrhages into the retina may cause retinitis from irritation of the nerve-fibers.

The disease is usually monocular and occurs in subjects from the fortieth to the sixtieth year.

Subjective Symptoms.—The patient may find on awaking in the morning that the sight of one eye is defective or destroyed. The amount of visual disturbance depends on the size and situation of the hemorrhage. A

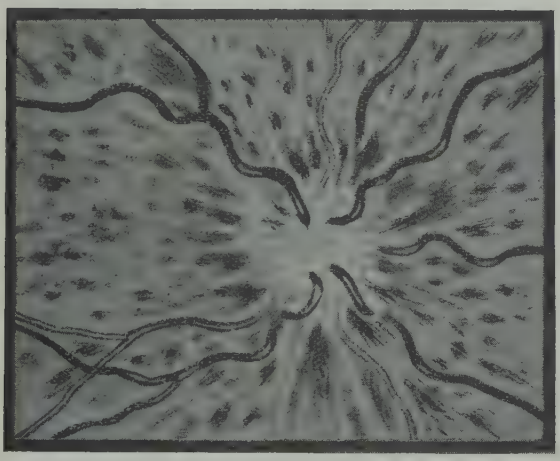

FIG. 75.—HEMORRHAGIC RETINITIS.

very small hemorrhage in the macula may cause considerable reduction in central vision.

Ophthalmoscopic Appearances. — 1. The Retina is cloudy, especially in the neighborhood of the disc. Numerous flame-shaped hemorrhages of various sizes are scattered over the fundus (Fig. 75). Stripe-like hemorrhages are found near the disc and along the course of the larger vessels. Toward the periphery the

hemorrhages are apt to be round and seated in the deeper layers of the retina.

2. The Disc is usually swollen, opaque, and its outlines obscured. Fine striped hemorrhages are found on the surface of the disc, and often its position is judged only by the grouping of the larger retinal vessels. In many cases the changes in the disc are insignificant.

3. The Retinal Vessels: The *arteries* are either normal or slightly narrowed. The *veins* are dark, greatly swollen, and tortuous. In many places they are concealed by the opaque retina.

Diagnosis.—This is not difficult when it is possible to exclude general systemic diseases.

Prognosis.—This is unfavorable, as a grave vascular or cardiac lesion is usually indicated. Relapses are common and the sight is apt to be permanently damaged by degenerative changes in the retina and optic nerve and by secondary glaucoma.

Treatment.—This consists in dark glasses and complete rest of the body and mind. The diet should be regulated and stimulants avoided. Digitalis should be used to control the action of the heart. Iodid of potassium and ergotin internally and strychnin by injection into the temples are recommended.

Retinitis Punctata Albescens (Retinitis Centralis Punctata et Striata) is a rare disease, first described by Mooren.

Etiology.—The cause is unknown, but it is probably of inflammatory origin.

Subjective Symptoms.—Central vision is usually low-

ered from the presence of a positive or relative scotoma; the peripheral field is unaffected.

Ophthalmoscopic Appearances.—These consist of numerous minute white glistening dots in the macula region, and fine white striæ which run like radii from the disc to the periphery of the fundus. The striæ or stripes lie behind the retinal vessels. Their edges are usually sharp and distinct and often bordered with pigment. There may be a diffuse opacity of the retina around the disc, and sometimes retinal and vitreous hemorrhages are observed. (See Nettleship's dots.)

The Disc is but slightly changed.

The Retinal Vessels may be normal or tortuous.

Diagnosis.—It is distinguished from retinitis proliferans by the fact that the striæ lie behind the vessels.

Prognosis.—The condition is chronic and may exist for years without showing any change.

Treatment.—This consists in the use of mercury and iodid of potassium.

Retinitis Circinata.—This is a term used by Fuchs to describe a rare form of inflammation which occurs in old people and somewhat resembles albuminuric retinitis.

Etiology.—According to De Wecker, it is due to hemorrhages in the retina, and is in the nature of a fatty degeneration.

Subjective Symptoms.—There is gradual failure of vision, central scotoma, and in the later stages, contraction of the field.

Ophthalmoscopic Appearances.—They consist of numerous white dots of irregular shape, which tend to run to-

gether to form patches arranged in an oval around the macula and reaching nearly to the upper and lower temporal vessels (Fig. 76). The patches lie behind the retinal vessels. The macula itself may be the seat of a gray or grayish-yellow opacity, and beyond this a zone of normal red fundus remains between the macula and the ring of spots. The remainder of the fundus is either normal

FIG. 76.—RETINITIS CIRCINATA.—(*Bruner.*)

or shows changes such as minute hemorrhages or colloid excrescences of the choroid.

The Disc may be normal or somewhat hyperemic and indistinct.

The Retinal Vessels are usually normal.

Diagnosis.—In senile changes at the macula the spots are yellow in tint, indistinctly outlined, and often bordered with pigment. In diabetic retinitis the spots rarely form a perfect ring about the macula.

Prognosis.—This is bad, though total blindness seldom occurs.

Treatment is of no avail.

Retinal Changes from the Effect of Intense Light.—Cases have been recorded in which, after exposure to a flash of electricity or to sunlight, as in watching an eclipse, the patient has complained of an intense burning pain in the eyes which lasted for several hours or days and of a persistent after-image or dark spot in the field (scotoma).

Ophthalmoscopic Appearances are negative, or the only change noted is a very delicate and gauze-like opacity in the macula region. In some cases there is a milky discoloration with a few small hemorrhages and yellowish dots in the macula, the remainder of the fundus being healthy.

Prognosis.—Vision usually improves, but in some cases never returns to normal.

Treatment.—Cocain and hot applications to relieve the corneal irritation, and confinement in a dark room for several days.

Symmetric Changes at the Macula Lutea in Infancy.—This is a rare disease, first described by Warren Tay.

Etiology.—According to Sacks, it is an arrest of development.

Pathology.—Autopsies show changes in the ganglion cells of the retina, in the cells of the cortex, and degeneration of the cord.

Clinical Signs.—The children exhibit apathy, paralytic weakness of the muscles, and gradually become blind.

Ophthalmoscopic Appearances.—These consist of a grayish-white area about the size of the disc in each macula region, with a cherry-red spot in the center, similar to that found in embolism of the central artery (Fig. 77). The rest of the fundus is normal. The papilla gradually becomes atrophic.

Prognosis.—Death occurs in from one to two years.

Purulent Retinitis may occur as a primary affection,

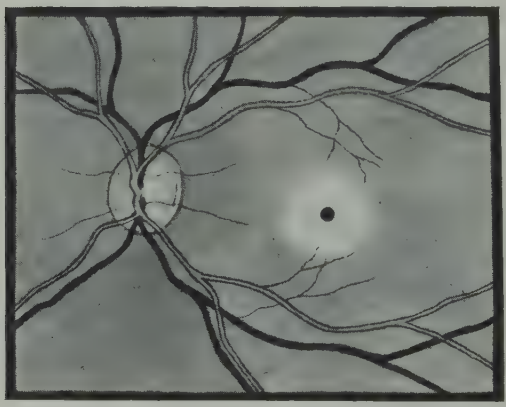

FIG. 77.—SYMMETRIC CHANGES AT THE MACULA IN INFANCY.—(*Tay.*)

but the clinical picture is identical with purulent choroiditis. (See page 88.)

Pigmentary Degeneration of the Retina (Retinitis Pigmentosa).—This is not, strictly speaking, a retinitis, but a degeneration of the retina characterized by deposits of pigment of peculiar form in the superficial layers of the retina, great contraction of the blood-vessels, atrophy of the optic nerve, and characteristic subjective symptoms.

Etiology.—The cause is obscure. It is often inherited, and a third of the cases have occurred in individuals descended from consanguineous parents. It is found among deaf-mutes, idiots, and epileptics, and is often associated with other congenital defects of the eye, as persistent hyaloid artery, posterior polar cataract, etc. Hereditary syphilis is a possible cause. The disease attacks both eyes and is either congenital or begins in childhood.

Pathology.—There is a migration of pigment from the pigment epithelium into the retina, associated with degeneration of the retina and disappearance of nerve elements. Some observers think the retinal degeneration has its starting-point in the choroid. The blood-vessels are in great part obliterated and converted into strands of connective tissue.

Subjective Symptoms.—1. Night-blindness: This is often the first symptom to attract the attention of the patient. He finds that his vision is worse as soon as twilight begins. As the disease advances the patient stumbles and is no longer able to go about alone at night, while in the daytime he still sees quite well.

2. Contraction of the Field of Vision: At first the field of vision is nearly normal, except under reduced illumination. Later it is very much contracted, even under strong illumination.

3. Diminution of Central Vision: Central vision may remain good for a long time, so that the patient is able to do fine work, although from contraction of the field he is unable to go about alone. Later, central vision suffers and the patient appears nearsighted from holding objects

close to the eyes. Finally, central vision is lost and the patient becomes blind.

4. Nystagmus: In advanced cases, especially when congenital, a rapid lateral oscillation of the eyeball is often observed.

Ophthalmoscopic Appearances.—1. Pigmentation of the Retina: The most prominent symptom of the disease is

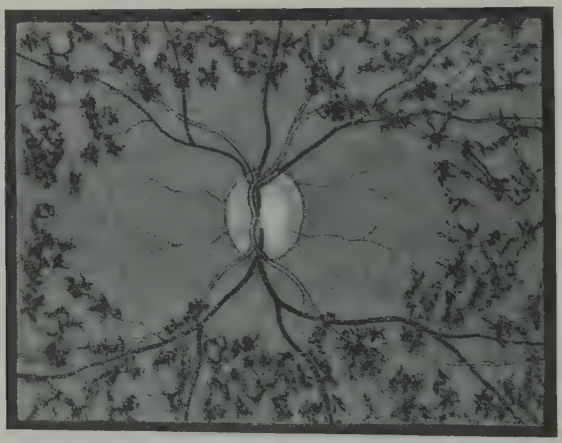

FIG. 78.—RETINITIS PIGMENTOSA.

the presence in the retina of small patches of pigment connected together by branching threads so that they resemble bone corpuscles or teased-out moss (Fig. 78). In the early stages of the disease the pigment is seen only at the periphery, especially on the temporal side, and may be limited to a few patches. As the disease progresses the irregular network of pigment slowly creeps toward the papilla, often along the course of the

main vessels, and at last invades the macula region. As fast as the retina becomes pigmented, the pigment epithelium undergoes absorption, exposing the larger choroidal vessels. This produces the tessellated fundus seen in some forms of choroiditis.

2. Contraction of the Retinal Vessels: The retinal vessels are greatly contracted, often to mere threads, and their number is diminished. They are often bordered by fine white lines from thickening of their walls. As the patches of pigment lie in the anterior layers of the retina, they *conceal* the vessels at the points they cross.

3. The Disc: The color of the disc is a dull white, often waxy, or of a pale yellowish-gray, like old parchment. The surface appears dull and flat, and while the edges may be slightly veiled, there is an entire absence of swelling.

4. Opacities of the Media: Posterior polar cataract may develop, but vitreous opacities are rare.

Atypical Forms.—Sometimes the black spots of pigment are not like bone corpuscles, but are round or of irregular shape, like the pigment spots of choroiditis. Cases occasionally occur which present most of the symptoms of retinitis pigmentosa, but without the deposits of pigment.

Diagnosis.—In a typical case the diagnosis is easy. In the early stages, when the deposit of pigment is scanty and confined to the periphery, the disease may be overlooked. In many cases of retinochoroiditis, especially when due to syphilis, the spots of pigment may assume the bone-corpuscle shape and present a picture not unlike retinitis pigmentosa; but in choroiditis the retinal

vessels cross in front of the pigment and there are also usually white spots of atrophy and vitreous opacities, which are wanting in retinitis pigmentosa.

Prognosis.—The prognosis is always unfavorable, for although the disease may remain at a standstill for several years, it gradually progresses until by middle life sight is practically lost.

Treatment.—Although little or no benefit is derived

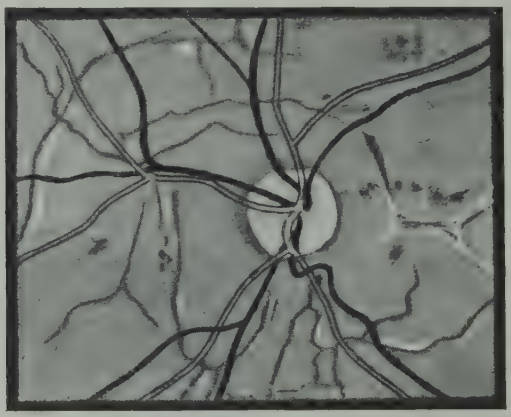

FIG. 79.—ANGIOID STREAKS IN THE RETINA.—(*Stephenson.*)

from any treatment, we may try iodid of potassium, mercury, subcutaneous injections of strychnia, and galvanism.

Pigment Streaks in the Retina; Angioid Streaks.—*Etiology.*—In most cases there is a history of a previous injury, and the presence of small hemorrhages would seem to point to the probability of a hemorrhagic origin. The disease is rare.

Subjective Symptoms.—Vision is usually lowered and both eyes are affected.

Ophthalmoscopic Appearances.—These consist of dark reddish-brown irregular streaks diffused through the deeper layers of the retina (Fig. 79). In many cases the streaks run in a radial direction from the disc. From their size, course, and mode of branching, they somewhat resemble obliterated blood-vessels. But the diameter of the streaks varies, and their borders are irregular and jagged. They all lie beneath the retinal vessels.

Retinitis Proliferans. — *Etiology.* — According to many, the disease is an inflammatory process, while Leber thinks it is the result of repeated hemorrhages. It is most commonly seen in young people.

Subjective Symptoms.—Vision is usually diminished and sometimes destroyed.

Ophthalmoscopic Appearances.—At the posterior pole of the eye are seen dense masses of connective tissue, which develop in the retina and extend out into the vitreous humor (Fig. 80). They are brilliant white in color, appear tightly stretched, and toward the periphery divide into processes which are attached to the fundus. They lie well in front of the retinal vessels, the course of which they often follow, and may conceal the disc and a considerable area of the fundus. Frequently newly formed vessels from the retina can be traced for some distance into the bands. Occasionally the vessels run for a distance on the surface of the connective tissue and then dip again beneath it. The disease may be complicated by opacity of the vitreous and detachment of the retina.

Diagnosis.—The appearances are characteristic and the diagnosis easy.

Prognosis.—The disease is chronic and may remain unchanged for years. There is danger of recurrent intra-ocular hemorrhage.

Treatment is of little or no avail. Internally, iron, mercury, and iodid of potassium.

FIG. 80.—RETINITIS PROLIFERANS.—(*Leber.*)

Detachment of the Retina.—This consists of a separation of the retina from the choroid.

Etiology.—Detachment of the retina may be caused by an injury or follow an operation in which a large quantity of vitreous has escaped. It is seen in retinitis, cyclitis, iridocyclitis in which the retina is drawn away from the choroid by exudates, and in shrinking of the vitreous. It frequently occurs in high degrees of myopia from fibrillary degeneration of the retina. Other causes

are purulent choroiditis, hemorrhages, tumors, and cysticercus in which the retina is pushed away from the choroid.

Pathology.—According to Leber and Nordenson, the primary cause is disease of the ciliary body and choroid, leading to shrinking of the vitreous; this produces a rent in the retina through which the fluid of the vitreous makes its way and separates the retina from the choroid. After the detachment has formed, the rods and cones, according to Klebs, are macerated by the fluid in which they float and become swollen, losing their structure and function.

Subjective Symptoms.—1. Central Vision: As long as the macula region is not involved central vision may be but slightly affected. Usually, however, vision is much reduced. The patient complains of distortion of objects, of a dark cloud or mist from the scotoma produced by the detachment, and of dark floating spots before the eyes, due to vitreous opacities. These symptoms may develop suddenly.

2. Field of Vision: The field of vision is lost in an area corresponding to the position of the detachment; for example, if the retina is detached below, the defect will be in the upper portion of the field, etc. In the early stages, before secondary changes have taken place, the defective area may retain a part of its functions. Total detachment is followed by absolute blindness.

Ophthalmoscopic Appearances.—The *detachment* appears as a delicate gray or bluish-gray membrane stretching forward into the vitreous and oscillating with the movements of the eye. It lies in folds whose tops show

a whitish sheen, and the furrows a greenish-gray reflex (Fig. 81). If the detachment is due to a tumor, neither folds nor tremulousness are present, and the growth may sometimes be recognized through the retina as a dark mass with vessels on its surface. Very frequently rents are found in the detached retina, through which the choroid may be discerned. These lie generally above and in the periphery of the fundus. The detach-

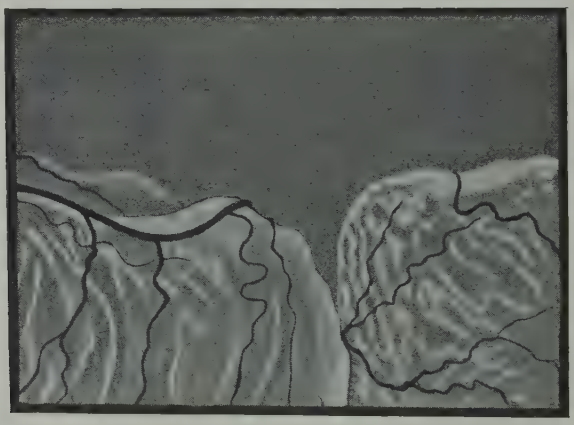

FIG. 81.—DETACHMENT OF THE RETINA.

ment may commence in any portion of the eye-ground, usually above; yet ultimately, from gravitation of the subretinal fluid, it sinks to the lower half of the fundus, while the part first detached may become replaced. In recent cases the detached area may retain most of its transparency. The detachment may be baggy, with overhanging edges, or its sides slope gradually into the surrounding retina. The papilla is often partially or

wholly concealed. Small detachments are difficult to recognize, the only change being slight cloudiness and a series of furrows in the retina. In most cases a detachment of the retina enlarges and finally becomes complete. It is then funnel-shaped, being attached at the papilla and spreading out anteriorly to reach the ora serrata.

The Retinal Vessels are very tortuous and follow the folds of the floating retina, sometimes appearing on the surface or again entirely concealed between the folds. They seem smaller than normal, like the vessels in high hypermetropia, and appear *dark red* or *almost black* from the fact that they are seen by transmitted light. The light streak is absent.

Method of Examination. — The detachment is best seen by the direct method at a short distance in front of the eye. By the direct method close to the eye the detachment will be found to be out of focus as compared with the rest of the fundus, and a stronger convex glass will be required. In many cases the detachment lies so far forward that it may be seen by oblique illumination as a gray membrane deep down in the eye.

Diagnosis.—Extensive detachments are easily recognized; small ones, especially when transparent, may be overlooked. The diagnosis may depend solely on the appearance of the vessels or on a study of the visual field when the fundus is obscured by vitreous opacities. Detachment of the retina might be mistaken for edema of the retina or retinitis proliferans. In edema the retina is softer, is not thrown into folds, and the vessels are not wavy. In retinitis proliferans the opacity is

more glistening and is tightly stretched. The shot-silk appearance of the retina observed in young eyes has been mistaken for a slight detachment.

Prognosis.—In rare instances the retina becomes reattached, but as a rule the prognosis is unfavorable, as in course of time the detachment becomes complete and the sight totally destroyed. In the later stages a low grade of iritis may set in, cataract develop, and the eyeball become soft and atrophic.

Treatment.—This consists of rest in bed and the use of a pressure bandage associated with pilocarpin sweats. Eserin may be instilled, and internally the use of iodids and salicylates. If this treatment fails, the subretinal fluid may be evacuated by puncture.

Subretinal Cysticercus is occasionally seen in Germany, but it is extremely rare in this country.

Subjective Symptoms.—At first the visual disturbance may be very slight, but in course of time sight is lost.

Ophthalmoscopic Appearances.—The entozoon is seated between the retina and choroid and appears as a sharply defined bluish-white body with bright orange margins. The head of the entozoon may be recognized as a very bright spot at one point of the cyst. The contour of the cyst may be seen to undergo wave-like motions. Characteristic veil-like opacities are apt to form in the vitreous. In many cases the entozoon pushes out into the vitreous, setting up an iridocyclitis which destroys the sight and leads to phthisis bulbi (Fig. 82).

Prognosis.—The eye is always lost unless the entozoon is removed.

Treatment.—An endeavor should be made to evacuate

the cyst through an opening in the sclerotic and choroid.

Glioma of the Retina (Amaurotic Cat's Eye).—This is the only tumor which occurs in the retina.

Etiology.—The cause is obscure. Faulty congenital development, the result of heredity, is undoubtedly a factor. The disease is either congenital or occurs in infancy, mostly before the fifth year. Several members

FIG. 82.—CYSTICERCUS.—(*Liebreich.*)

of the same family may be afflicted. Glioma, as a rule, involves only one eye, although numerous bilateral cases have been observed.

Pathology.—The tumor consists of unpigmented nucleated cells, which develop from the granular layers of the retina, especially from the inner granular layer, and are surrounded by a very soft basement membrane.

Symptoms.—In the *first stage* inflammatory symptoms

are absent. The parents may notice a whitish reflex from the pupil and by various tests discover that the eye is blind. When examined by focal illumination, this reflex is seen to be caused by a whitish or grayish-red nodular mass situated deep in the eye and covered over with minute blood-vessels.

In the *second stage* the eye becomes irritated and painful and the tension becomes elevated (secondary glaucoma).

In the *third stage* the tumor fills the eyeball and grows out along the optic nerve. Finally it bursts outward, usually at the corneoscleral margin, grows more rapidly, and appears as a painful, ulcerated, and bleeding mass, which fills the orbit and projects out from between the lids.

In the *fourth stage* the tumor spreads to the brain and other distant organs, most frequently to the liver.

Diagnosis.—The diagnosis is often difficult. Masses of tubercle in the choroid may be mistaken for glioma; also for persistence of the posterior part of the fetal fibrovascular sheath of the lens (Collins) and for inflammatory or purulent exudation into the vitreous with detachment of the retina, the result of retinitis or cyclitis (pseudoglioma). In *glioma* the anterior chamber is uniformly shallow, the tension is usually increased, and in the early stages there are no iritis, cyclitis, or vitreous opacities. The tumor usually has a lobulated appearance. In *pseudo-glioma* the anterior chamber is deepened at its periphery and shallow at its center; the tension is diminished and there are posterior synechiæ and other evidences of a previous inflammation. The lobulated

appearance is not so usual as in glioma. When in doubt, enucleate the eye.

Prognosis.—If not removed, the patient dies in a year or so from exhaustion or from the spread of the tumor to the brain or other vital organs. The only hope is to remove the growth before the optic nerve or orbit is involved. If the tumor does not return within three years after its removal, the patient is reasonably safe.

Treatment.—The eye must be enucleated at once, dividing the optic nerve as far back as possible and dissecting out all suspicious tissue from the orbit.

CHAPTER VIII.

DISEASES OF THE RETINAL VESSELS.

Sclerosis of the Vessel Walls.—This consists in a hyaline thickening and degeneration of the walls by which the lumen of the vessel is much reduced or ob-

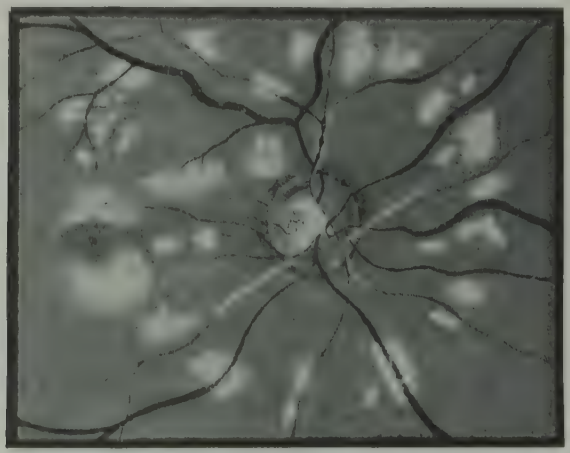

Fig. 83.—Sclerosis of the Vessel Walls after Embolism Associated with Retinal Changes Due to Bright's Disease.

literated. The vessel walls retain their transparency, so that the only changes observed are a reduction of the diameter of the red blood column (Fig. 83), increased width of the light streak, and a broken appearance of the vein at the point where the artery crosses it. The

disease usually attacks the arteries and capillaries, less frequently the veins. It may occur in any form of retinal inflammation, but is most commonly observed in retinitis pigmentosa and in retinitis due to nephritis and syphilis.

Perivasculitis.—This consists of a hyperplasia of the connective-tissue elements of the outer covering of the vessel. It is characterized by the appearance of

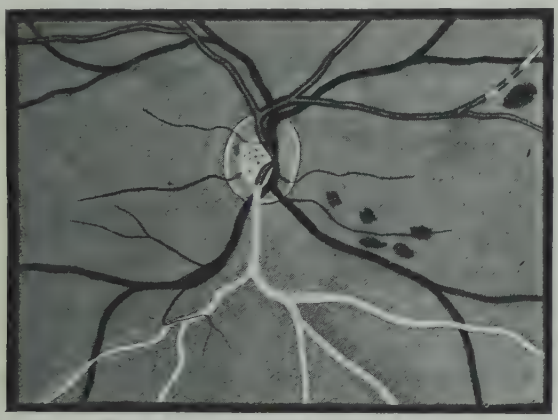

FIG. 84.—PERIVASCULITIS.

white lines along the vessels. In rare cases the column of blood is entirely concealed and the vessels appear as a series of branching white bands (Fig. 84). These bands may cease suddenly and alternate with lengths of red blood. The disease is due to inflammation of the retina and optic nerve.

Aneurysm.—Aneurysm of the retinal arteries is extremely rare. Aneurysms of some size on the larger

vessels and pulsating synchronously with the heart have been described. Miliary aneurysms in the small arterial twigs are more common and are usually associated with a similar condition of the vessels in other organs, especially the brain. They appear as small globular dilations with a widened light streak, often situated at the branchings of the vessels. Varicosities in the veins and minute hemorrhages should not be mistaken for aneurysms.

Embolism and Thrombosis of the Central Artery of the Retina.—The central artery may become occluded either by a clot carried into it from a distance—embolism, or more frequently by a clot forming in the vessel itself —thrombosis. The ophthalmoscopic appearances are identical.

Etiology.—The most frequent cause of *embolism* is valvular disease of the heart, especially when complicated with fresh endocarditis ; other causes are general arterial sclerosis, aneurysm of the aorta or of the carotid, Bright's disease, pregnancy, and occasionally chorea. Usually one eye only is affected. The causes of *thrombosis* are roughness of the vessel lining, great retardation of the circulation, as in syncope, or in some cases the result of spasm of the arterial walls. The latter would account for the transient attacks of blindness which in many cases precede the sudden loss of sight.

Subjective Symptoms.—The characteristic symptom is sudden loss of vision, often preceded by transient attacks of blindness, flashes of light, scintillations, or the appearance of dark rings before the eyes.

Ophthalmoscopic Appearances.—If seen immediately

after the plug has blocked the artery, signs of extreme retinal anemia are observed.

1. Changes in the Arteries: The larger arteries may be only slightly smaller than normal or reduced to mere threads, while the smaller vessels become invisible. The light streak is absent and the arteries become darker, so that they may closely resemble the veins. Very frequently the blood stream is broken up into short sections separated by clear interspaces like the column of mercury in a broken thermometer.

2. Changes in the Veins: The veins may be normal in size or somewhat contracted, especially toward the disc. The blood stream is often intermittent and may make jerky movements in the usual or reverse direction.

3. Changes in the Disc: The disc appears grayish-white from anemia of its capillaries and its outlines are obscured.

4. Changes in the Retina: Within a short time (a few hours) the retina at the posterior pole of the eye loses its transparency, and becomes milk white or grayish-white, with a faint reddish tint of the normal fundus shining through. The opacity forms a large horizontal oval, with the macula as the center and on the nasal side reaches to or beyond the disc (Fig. 85). The outer boundaries of the opacity fade imperceptibly into the surrounding healthy retina. This soft-looking white opacity closely resembles edema, but, according to Frost, is probably due to postmortem changes.

5. Changes at the Macula Lutea: At a point corresponding to the position of the fovea is an intense cherry-red spot about one-fourth the diameter of the disc, which

presents a strong contrast with the surrounding milky white area. It resembles a round hemorrhage, but is really the natural color of the choroid showing through the retina, which is thinnest at this point. Small retinal hemorrhages in the macula region have, however, been observed.

Appearances in Later Stages: In the course of sev-

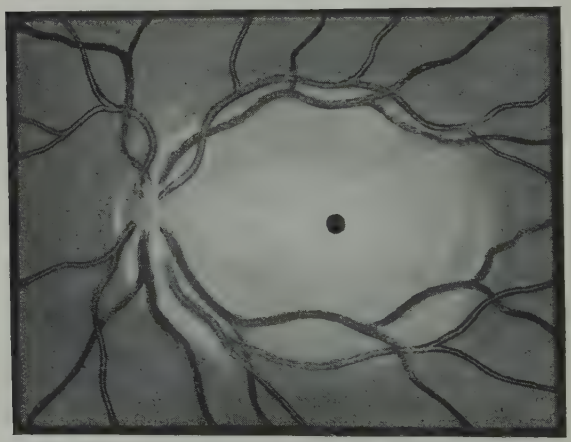

FIG. 85.—EMBOLISM OF THE CENTRAL ARTERY OF THE RETINA.

eral weeks the cloudiness of the retina subsides; it regains its transparency, but becomes perfectly atrophic. The optic disc undergoes atrophy and becomes white and sharply outlined. The retinal vessels are shrunken and many of them become nearly or quite invisible. The vessels may be bordered by white lines or even be converted into white cords. Remains of hemorrhages in the shape of spots of degeneration and pigment mark-

ing may be seen around the disc and in the macula region.

Embolism Affecting only a Branch of the Central Artery.—Here the visible changes are limited to that portion of the retina supplied by the obliterated vessels. In some instances the plug may be seen as a yellowish body, but more frequently there is a swelling at one point in the artery, beyond which the vessel is completely obliterated or reduced to an extremely thin caliber. The blindness corresponds to the diseased portion of the retina, and appears as a defect in the visual field. Central vision may be normal. Even in embolism of the central artery itself some sight may be retained, especially when the retina is supplied by a cilioretinal vessel.

Re-establishment of the Retinal Circulation.—Cases are on record where the retinal circulation was re-established in a few hours, with restoration of the normal ophthalmoscopic appearances and recovery of practically normal vision. If the circulation is re-established gradually and after a longer interval, recovery of sight is seldom complete. It is found that when the nervous elements of the retina are deprived of arterial blood for only a few hours, degeneration takes place which may involve the optic nerve as high as the chiasm.

Diagnosis.—The appearances just described may be due to embolism, thrombosis, or hemorrhage into the sheath of the optic nerve. According to Priestley Smith, previous attacks of temporary blindness in the affected eye, a simultaneous attack of temporary blindness in the unaffected eye, and giddiness, faintness, and headaches

are symptoms found in thrombosis, but are absent in embolism.

Prognosis.—This is exceedingly unfavorable, and in most instances the blindness is permanent, from subsequent atrophy of the nerve. The prognosis is more favorable in embolism of a branch, or when a portion of the retina is supplied by a cilioretinal vessel.

Treatment.—This consists in an attempt to drive the plug into a smaller vessel, where it will do the least harm. With this object in view, massage of the eyeball should be tried or the tension suddenly reduced by paracentesis of the anterior chamber. Nitrite of amyl inhalations are recommended by Gifford.

Thrombosis of the Retinal Veins.—*Etiology.*—This condition is occasionally seen as a result of phlebitis, atheroma of the vessels, and also with heart disease.

Subjective Symptoms.—Central vision is reduced, and in severe cases complete blindness results from atrophy of the nerve.

Ophthalmoscopic Appearances.—1. The Retina: Numerous hemorrhages of a dark red color, striated or irregularly rounded in shape, are scattered over the entire fundus (Fig. 86). The retina between the patches of hemorrhages is clouded and of a faint gray color. The macula is yellowish-gray, with a hemorrhage at the fovea.

2. The Disc appears discolored and its margins streaked and obscured.

3. The Vessels: The *veins* are enormously distended, tortuous, and filled with blackish blood. There is often pulsation, with here and there an interrupted circulation.

The *arteries* are narrowed and often invisible. In many places the vessels are covered by the extravasations.

4. The Vitreous: Floating opacities in the vitreous are frequently seen.

Diagnosis.—This condition may resemble embolism, but is distinguished from it by the presence of retinal hemorrhages and tortuosity and distention of the veins.

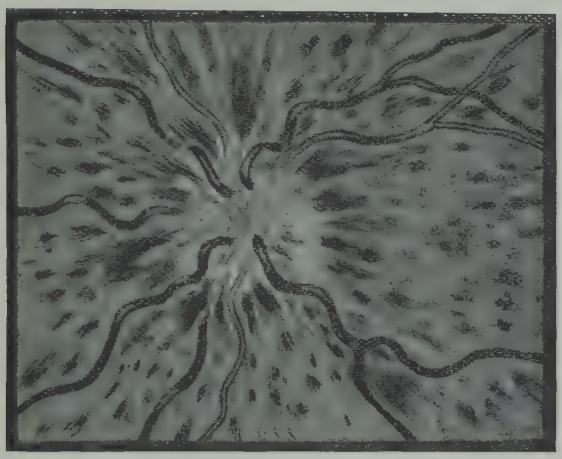

FIG. 86.—THROMBOSIS OF THE RETINAL VEINS.

Prognosis.—In some cases sight improves, but usually fresh hemorrhages occur which still further reduce the visual acuity.

Treatment.—This consists in promoting absorption by means of mercury and iodids.

Hemorrhages in the Retina; Apoplexy of the Retina.—Here the hemorrhages are found in a retina free from inflammation or other diseased conditions.

Etiology.—Hemorrhages in the retina may be due to trauma, either the result of an accident, or after operations or pressure on the skull at birth ; they may be due to heart disease, atheromatous vessels, embolism, or thrombosis of the central artery or vein. Hemorrhages frequently occur in extreme anemia, leukemia, sepsis, albuminuria, diabetes, etc.

Subjective Symptoms.—The defect of vision depends

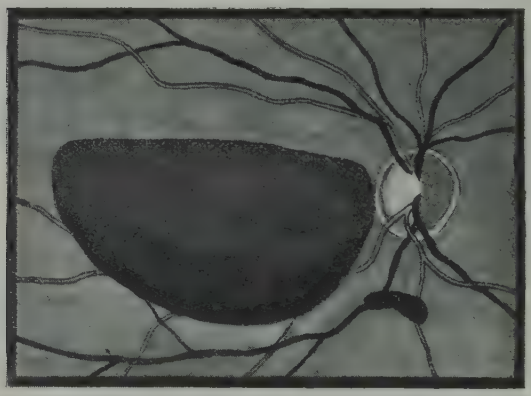

FIG. 87.—SUBHYALOID HEMORRHAGE.

on the size, number, and locality of the hemorrhages. If situated in the periphery, central visual acuity may be unimpaired, while if they lie in the macula region vision is almost, if not entirely, destroyed. The defect of vision usually comes on suddenly.

Ophthalmoscopic Appearances.—The hemorrhages are of various sizes and shapes, of a darker red than the surrounding fundus and are most frequently found in

the macula region and along the course of the larger vessels (Fig. 86). Hemorrhages originating in the nerve-fiber layer are striated or flame-shaped, while those situated in the deeper layers of the retina, or between it and the choroid, are of rounded or irregular shape.

Subhyaloid Hemorrhages.—This is an extravasation situated between the retina and the vitreous, usually in the macula region. At first the hemorrhage is round and of a uniform color; but in a few days the blood, from the action of gravity, sinks to the lower part of the affected area, assuming a semilunar shape, with the convexity downward (Fig. 87). After some time the hemorrhage becomes thinner, of a slate gray color, and is sprinkled with minute dots of a crystalline appearance. Vision is defective, and objects are seen through a red mist.

Prognosis.—Retinal hemorrhages become absorbed very slowly and ultimately disappear without leaving a trace of their presence, or they leave decolorized whitish or pigmented spots in the fundus. Recurrences of the hemorrhages are very common. Hemorrhagic glaucoma, detachment of the retina, and the formation of dense opacities in the vitreous humor are complications sometimes met with.

Treatment.—Rest, avoidance of violent muscular effort, and dark glasses. Cold compresses with a pressure bandage may be employed, while internal treatment will be governed by the probable cause.

CHAPTER IX.

DISEASES OF THE OPTIC NERVE.

Hyperemia of the Optic Disc.—*Ætiology.*—It may be present in cardiac lesions, in advanced cases of diabetes, or as the result of the various inflammatory conditions of the cornea, sclera, iris, ciliary body, choroid, and retina. It is most frequently seen in hysteria, neurasthenia, and nervous asthenopia from eye-strain.

Subjective Symptoms.—The patient complains of muscæ volitantes, dimness of vision (often imaginary), pain in and behind the globe, and frontal and temporal headaches.

Ophthalmoscopic Appearances.—The ordinary tint of the disc deepens to a dull red, which shows a tendency to invade or obscure the physiologic cup. The surface of the disc has a soft look, and the striated appearance of the nerve-fibers at its edge becomes more pronounced, tending to *blur*, but *not conceal*, the disc margins. These changes are best seen by the direct method. The *retinal vessels* are normal, or at most the veins are enlarged. The vessel walls may be thickened and appear as white lines bounding the blood column.

Diagnosis.—Since the color of the optic disc varies widely within physiologic limits, the diagnosis of hyperemia of the disc is difficult and cannot be made by the color alone. Pathologic redness may be suspected

when it affects only one eye or develops under observation.

Prognosis.—This is good if the cause is removed. Hyperemia of the disc is a chronic condition which rarely passes over into actual neuritis except when the congestion is due to retrobulbar neuritis.

Treatment.—Rest of the eyes, a mydriatic, dark glasses, and tonics.

Optic Neuritis or Papillitis.—*Etiology.*—The most frequent cause of optic neuritis is tumor of the brain, irrespective of size or position. The new growth causes an increase of intracranial pressure, and the resulting neuritis is apt to take the form of a choked disc. The next most frequent cause is meningitis, especially of tubercular or syphilitic origin. Other causes are softening of the brain, acute infections, febrile diseases, syphilis, toxic agents like lead, and acute anemia after great loss of blood. In these cases the neuritis is almost always bilateral. Occasionally optic neuritis has a local origin, as in inflammation or tumors of the orbit and optic nerve. Here the neuritis is unilateral.

Subjective Symptoms.—1. The Vision: In most cases central vision is much reduced, and in severe cases sight may be lost. Occasionally visual acuity is unaffected even when the neuritis is marked. The patient often complains of severe headaches and of sudden and momentary obscurations of sight.

2. The Field of Vision may be unaffected at first, but later shows irregular and concentric contraction, hemianopsia, scotoma, and defective color perception.

Ophthalmoscopic Appearances.—1. The Disc: The

first stage of optic neuritis is hyperemia with edema. The disc is stained a deep red, the radiating striation of the nerve-fibers is marked, and the edges of the disc are blurred to direct, but still faintly outlined to indirect, examination. These changes are more pronounced on the nasal side (Fig. 88). In the *later stages* of the disease the outline of the disc is entirely obliterated (Fig. 89), the normal semi-transparent appearance of the papilla is lost, and it assumes a characteristic reddish-gray tint or

FIG. 88.—OPTIC NEURITIS, EARLY STAGE. FIG. 89.—LATER STAGE.

a red hardly to be distinguished from the red of the surrounding choroid. The swelling often entirely obliterates the central cup, which then appears stippled or uniform, and of a darker red than the periphery of the disc.

2. The Retinal Vessels: In the early stages of neuritis the *arteries* are usually of normal size, but are inconspicuous, as they resemble the color of the disc and are buried more or less in the swelling. Rarely the arteries may be seen to pulsate. The *veins* appear dark,

foreshortened, may or may not be dilated, and lose their central light streak as they curve over the swelling. They are apt to be concealed just beyond the edge of the disc in the adjacent retina.

Choked Disc.—According to Uhthoff, choked disc is said to be present when the swelling passes beyond three diopters. The disc increases in size laterally as well as in height, often having a diameter two or three times that of the normal disc (see Frontispiece, Fig. 5). The height of the swelling may be estimated with the ophthal-

Fig. 90.—Choked Disc, Longitudinal Section.—(*Fuchs.*)

moscope | 3.00 D 1 mm. In choked disc there is strangulation of the papilla and compression of the vessels (Fig. 90). The inflamed papilla is a deep red, mottled and streaked from enlarged vessels and small extravasations. The normal striation of the nerve-fibers is commonly lost. Flame-shaped hemorrhages are often seen on the edge of the swelling and scattered over the whole fundus, and diffuse cloudy opacities in the retina often occur along the course of the vessels.

In choked disc *the arteries* are much narrowed, are buried in the substance of the swelling, and first appear

in the retina a little distance from its edge. They are always more concealed than the veins, and are often represented on the disc by white lines or spots.

The veins are greatly distended and may be entirely concealed on the disc, but usually some of them are visible toward the edge of the swelling. As they pass over into the retina they are very tortuous both laterally and in an *anterior posterior* plane.

Subsidence of Neuritis.—After a longer or shorter period the swelling gradually subsides, the disc becomes paler, and its outlines begin to show dimly, first on the temporal and then on the nasal side. The disc has a white filled-in look, and while the physiologic cup may again appear, the lamina cribrosa is usually permanently veiled. The *arteries* and *veins* are narrowed, and as they emerge from the center of the disc are often partially concealed by whitish tissue. The walls of the vessels near the disc often become more hypertrophied and show as white lines ; this is an important symptom of a preceding inflammation. Finally, when the disc resumes its natural size and distinct outlines, it is found to be atrophic and of a grayish color. A disturbance of the retinal and choroidal pigment leads to a narrow zone of atrophy adjacent to the disc, or causes the disc to have irregular edges. The hemorrhages in the retina may become absorbed, leaving no trace, or be transformed into spots of pigment. Sometimes white spots are left which may present a striking resemblance to those seen in albuminuric retinitis. If the neuritis has not been prolonged or severe, the disc may assume its normal color.

Diagnosis of Optic Neuritis.—In well-marked cases of papillitis the diagnosis is easy. The blurring of the disc, caused by opacities of the media, or congestion from eye-strain, must not be mistaken for papillitis.

Prognosis.—In all cases the prognosis is serious. The duration of the disease varies greatly; slight degrees may persist for months or years without much change for the worse, while intense strangulation may develop in a few days. Usually, in the course of a few months the symptoms of inflammation subside and disappear, being replaced by the symptoms of atrophy. Vision may improve, but usually is permanently impaired.

Treatment.—This must be directed first against the cause of the neuritis. Mercury and iodid of potassium are indicated for their alterative action even in non-syphilitic cases. Rest for the eyes, atropin, and dark glasses are to be recommended.

Retrobulbar Neuritis (Toxic Amblyopia).—This consists of an acute or chronic inflammation, the latter limited to the nerve-fibers which supply the region of the macula lutea. These fibers form a wedge-shaped segment, occupying the temporal side of the disc (papillomacular bundle of fibers).

Etiology.—The *acute* form of the disease is caused by toxic doses of quinin, salicylic acid, etc., heredity, overwork, great chilling of the body, acute infectious diseases, and other disturbances of nutrition. The *chronic* form is caused by chronic poisoning by nicotin, alcohol, or lead.

Subjective Symptoms.—In the *acute form* of retrobul-

bar neuritis there is sudden and marked impairment of sight and excessive contraction of the visual field, often accompanied by violent headache and pain in the orbit. In severe cases complete blindness may develop in the course of a few days.

In the *chronic form* of the disease the disturbance of vision comes on so gradually that the patient is unable to tell exactly when it began. Both eyes are usually affected to the same degree, which distinguishes tobacco amblyopia from atrophy of the optic nerve, neuritis, cataract, etc., in which the dimness of vision is almost always more pronounced in one eye than in the other. The patient also complains of nyctalopia, *i. e.*, vision is better in the evening than it is in the daytime. The visual field is normal, but there is a central scotoma, especially for red and green. In extreme cases, even light perception is lost in this central area, and the scotoma becomes absolute.

Ophthalmoscopic Appearances.—In the *acute form* there is atrophy of the nerve and narrowing of the retinal vessels. In the *chronic form* the ophthalmoscopic appearances are sometimes negative; more frequently there is congestion of the nasal half of the disc, with dull pallor of the temporal wedge-shaped segment. The edges of the disc are softened and the surrounding retina hazy. The retinal vessels are of normal size. Sometimes the light streak is diminished and faint white lines are found along the vessels, especially on the disc. Occasionally, in advanced stages, the whole papilla becomes atrophic.

Diagnosis.—In most cases of tobacco amblyopia the

diagnosis cannot be made on the ophthalmoscopic picture alone, but depends upon dimness of vision associated with a central scotoma for red and green.

Prognosis.—The prognosis is favorable in the chronic form if the cause is removed. Vision gradually returns to normal in the course of three to six months. In the acute form due to quinin, the neuritis is followed by atrophy and the lost vision is never regained.

Treatment.—This consists in total abstinence from the use of tobacco, quinin, etc., and the use of strychnia and iodid of potassium.

Atrophy of the Optic Nerve.

This consists in a wasting or degeneration of the optic nerve-fibers, together with the capillaries which supply them. The disease may develop either as a primary affection or as secondary to a previous inflammation. Both varieties have certain symptoms in common.

Subjective Symptoms.—1. Lowered Visual Acuity: There is diminution of central vision, which varies from a slight degree to complete blindness, and is usually, though not always, proportionate to the damage to the nerve-fibers. If the atrophy is bilateral, vision is almost always more affected in one eye than in the other.

2. Contraction of the Field of Vision for Form (white): The most common defect is a concentric contraction, progressing until only a small central area of vision is left. In some cases there may be quadrant-shaped defects, complete loss of one-half of the visual field (hemianopsia), or a central scotoma.

3. Contraction of the Field of Vision for Color: The

color vision is always affected early in the disease, sometimes before any change is noted in the form field. Usually there is contraction of the field for colors in the following order: green, red, blue, and yellow.

4. The Pupil: In many cases there is more or less paralytic mydriasis, depending upon the degree of the atrophy. In other cases, especially in that form of atrophy due to tabes, the pupils are small, reacting to accommodation and convergence, but not to light (Argyll-Robertson Pupil).

Ophthalmoscopic Appearances.—1. Pallor of the Disc: The color of the disc varies from a slight grayish-red pallor to a pure gray, greenish-gray, or white. The pallor may extend over the whole area of the disc, but is usually most marked on the temporal side. The presence of the physiologic cup and the scarcity of nerve-fibers make the temporal side normally almost as pale as in atrophy. Hence, when pathologic pallor is suspected, attention should be fixed on the nasal portion, which normally possesses a reddish tinge.

2. Excavation of the Disc: The shrinking of the atrophic nerve, while not affecting the size of the disc, causes an excavation of its surface (atrophic cup). The size and shape of the excavation depend upon the amount of shrinking of the nerve and the size of the physiologic cup. In some cases an overgrowth of connective tissue may to some extent compensate for the shrinking due to the atrophy, so that the depression of the disc may be slight or absent. The characteristic feature of an atrophic cup is that it commences at the scleral ring, *affects the whole disc*, and has a very gradual

slope. The mottling of the lamina cribrosa is usually very distinct and the retinal vessels can be traced down the cup without any interruptions.

3. The Margin of the Disc: The margins of the disc are very distinct and clear cut, from contrast with the surrounding choroid. Any deposit of pigment on the edge of the disc is unusually conspicuous. In the atrophy which follows a neuritis or retinitis the margins of the disc are more or less obscured.

4. The Retinal Vessels: In many cases of *primary atrophy* the vessels present a normal appearance. Sometimes the arteries are narrowed and the veins unchanged. In *secondary atrophy* both arteries and veins are usually very much contracted, and may be bordered by white lines or appear as white threads.

Primary or Simple Atrophy is an atrophy which develops without a previous inflammation of the nerve. Both eyes are usually affected, one much more and earlier than the other.

Etiology.—1. The most frequent cause is locomotor ataxia, in which disease atrophy of the nerve is said to occur in 33.7 per cent. of cases, and usually beginning in the pre-ataxic stage. Primary atrophy also occurs in other forms of spinal disease, as general paralysis of the insane, insular sclerosis, but less commonly in lateral sclerosis. According to Leber and Norris, primary atrophy may be hereditary, affecting especially the males of a family.

2. Primary atrophy may be due to blows on the head causing direct injury to the nerve, or a gradual degeneration from shock. It may result from compression of

the optic tract, or optic nerve around the optic foramen, from tumors, exostosis, aneurysm, internal hydrocephalus, or in rare cases from meningitis, without intra-ocular inflammation.

Special Ophthalmoscopic Appearances.—1. The Disc: In the early stages, according to Norris, there may be hyperemia of the disc with haziness of the scleral ring. Later, when the disease has progressed, the disc is gray or white, translucent, and is surrounded by a sharply cut scleral ring (Frontispiece, Fig. 6). The excavation is saucer-like, involving the whole disc, and the stippling of the lamina cribrosa is very distinct.

2. The Blood-Vessels: The capillary blood-vessels of the disc have disappeared, while in most cases the retinal vessels do not present any marked change in their caliber or appearance.

Secondary Atrophy.—This is the form which occurs after optic neuritis, violent forms of retinitis and choroiditis, embolism, and glaucoma.

(*a*) Postpapillitic Atrophy.—*Ophthalmoscopic Appearances* (Fig. 91).—The color of the disc is a chalky opaque white, lacking the translucency seen in the primary form of atrophy. The new-formed tissue which covers the disc gives it a filled-in look, and although in time the contraction of the tissue may cause an excavation of the disc, it rarely becomes sufficient to reveal the stippling of the lamina cribrosa. The edge of the disc is slightly veiled and has a more or less irregular outline from atrophy of the adjacent choroid.

The Retinal Vessels: The arteries are narrowed, sometimes to a marked degree. The veins usually be-

come contracted, but in some cases are distinctly tortuous and in marked contrast to the thread-like arteries. Often, in the neighborhood of the disc, white lines are found along the blood-vessels, probably due to connective-tissue thickening of the outer coat.

Course of the Atrophy.—After a long time the white disc may become distinctly grayish, and if the preceding

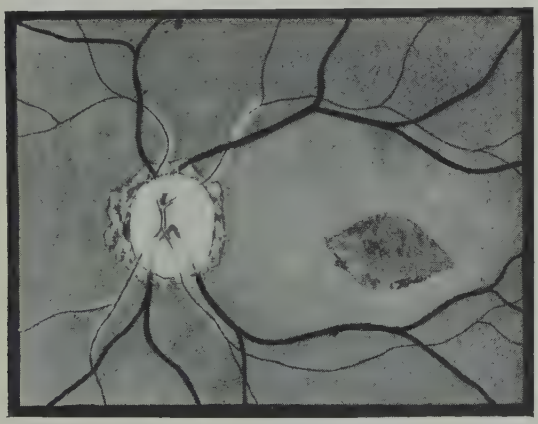

FIG. 91.—SECONDARY ATROPHY OF THE NERVE IN A CASE OF EMBOLISM OF THE CENTRAL ARTERY OF THE RETINA.

inflammation has not been marked, it may be difficult to distinguish it from the disc of simple atrophy, or from that of retrobulbar neuritis. According to Gifford, a network of newly formed blood-vessels is sometimes left on the disc, and is the most permanent sign of a previous neuritis.

(*b*) RETINAL OR CHOROIDAL ATROPHY.—An atrophy

of the disc often follows severe forms of retinochoroiditis, and always accompanies retinitis pigmentosa.

Ophthalmoscopic Appearances.—The disc is white or gray, resembling primary atrophy, or it may be of a yellowish-red tint with blurred edges and marked wasting of the retinal vessels. In the *retinochoroiditis* due to hereditary or acquired syphilis, the atrophy of the disc is usually incomplete and the narrowing of the vessels less marked.

In *retinitis pigmentosa* the disc has a waxy look and the vessels are narrowed to such a degree as to be scarcely visible.

(*c*) Embolic Atrophy.—Embolism and thrombosis of the central artery and central vein are followed by atrophy of the nerve, due to degeneration following the destruction of the nerve elements in the retina.

Ophthalmoscopic Appearances.—The color of the disc is a dense opaque white, or yellowish-white, and the larger retinal vessels are reduced to the size of fine threads, while the smaller ones have disappeared altogether (Fig. 91).

(*d*) Atrophy and Cupping of the Disc Due to Glaucoma.—Under the influence of increased intraocular pressure, the lamina cribrosa is pushed backward and the tissue in front of it is absorbed so that a more or less deep excavation or cup is formed in the head of the nerve.

Ophthalmoscopic Appearances.—1. Excavation of the Disc: In the early stages of glaucoma the disc is of normal color or hyperemic, and the depression so slight as to easily escape notice. As the process advances, the

excavation increases in depth, and the hyperemia becomes less. When fully formed, the excavation is complete to the scleral margin and its edges are abrupt or undermined (Fig. 92). The nerve tissue becomes more or less atrophic, exposing to view the lamina cribrosa. The *vessels* are crowded to the nasal side, bend sharply over the margin, and are lost to view until they reach the bottom of the cup, where they reappear, but out of focus. The excavation in the nerve may be demon-

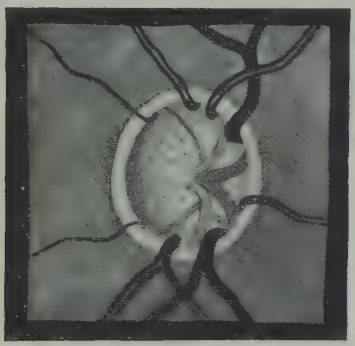

FIG. 92.—GLAUCOMA CUP.

strated by the parallax test, and its depth estimated by means of a concave lens 3 D = 1 mm.

2. Pulsation of the Arteries is a characteristic symptom. It is usually observed on or near the disc, and consists of a rapid alternate filling and collapse of the vessel.

3. A Ring or Halo of a yellowish-white color surrounds the disc. This is a characteristic symptom and is due to atrophy of the choroid.

Diagnosis of Normal and Abnormal Cupping.—It is important to distinguish between the three varieties of excavation in the nerve head (Figs. 93, 94, 95). A *physiologic cup* (A) is partial, funnel-shaped in a nerve of normal color. An *atrophic cup* (B) is complete, saucer-shaped in a nerve of abnormal whiteness, while a *glaucomatous cup* (C) is complete, deep with abrupt or undermined edges in a nerve which is white or of greenish hue. Sometimes it is difficult to distinguish between an atrophic and a glaucomatous excavation when the latter is only forming; or between a physiologic cup and glaucoma when the former is associated with a primary atrophy of the optic nerve (de Schweinitz).

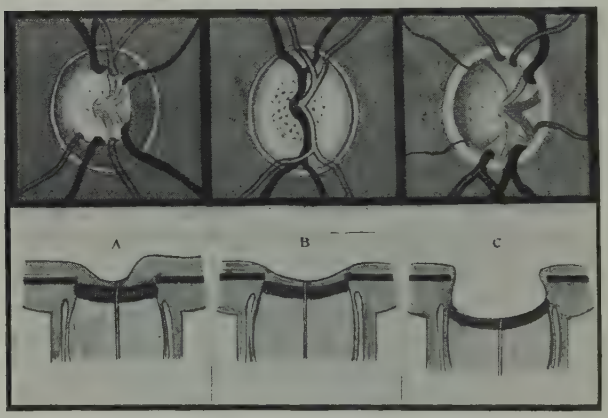

Fig. 93. Fig. 94. Fig. 95.

The Three Kinds of Excavation of the Optic Nerve, with Cross-section of Each.

Fig. 93, Physiologic; Fig. 94, Atrophic; Fig. 95, Glaucomatous.

The diagnosis will then depend upon the state of the field of vision and other symptoms. In atrophy the *color vision* is always affected early in the disease, while in glaucoma it is a late symptom.

Diagnosis of Atrophy of the Optic Nerve.—In estimating the slighter degrees of atrophy it is important to keep in mind the normal variations in color of the disc. As a rule, the disc becomes paler as life advances, so that a tint which is normal in the old would be suggestive of atrophy in the young. It must also be remembered that in dark eyes the disc may seem abnormally pale as an effect of contrast with the deep red of the surrounding fundus. A disc which appears chalky white to the indirect method may appear grayish to the direct method. In judging of the color of the disc, a weak illumination should be used, as a strong light makes a faintly tinted disc appear white.

Prognosis.—The prognosis of atrophy of the optic nerve is always grave. In *primary atrophy* the sight gradually fails until complete blindness is the result. In *secondary atrophy* the prognosis is more favorable, as the amount of sight left after the neuritis or retinitis has run its course is usually permanently preserved.

Treatment.—This consists in remedies directed to the removal of the cause. For the lesion of the optic nerve itself, mercury, iodid of potassium, arsenic, and strychnia are employed. The constant current applied to the eye itself may be of benefit.

INDEX.

D.

E.

O.

P.

R.

S.

T.

V.

W.

Y.

Z.

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